Gulf of Mexico Land-Based Pollution Sources Inventory

Project Description

The Gulf of Mexico Land-Based Sources Inventory is a digital database that contains information on the location, timing, and magnitude of point and nonpoint source discharges to the rivers, streams, lakes, and estuarine and coastal waters of the Gulf of Mexico drainage area. This site offers point and upstream source estimates for a base period of 1991 and nonpoint source estimates for 1989-1995.

The inventory is the most comprehensive characterization of pollutant discharges ever developed for the Gulf of Mexico region, and serves as a valuable new assessment tool for interjurisdictional management. It provides resource managers throughout the Gulf with an overall picture of the types and amounts of pollutant discharges generated by land-based activities and allows them to estimate both the existing and future relative contributions of point and nonpoint pollutant discharges within and across watersheds. Managers can use this information to better target pollution control strategies and to identify resources in the watersheds that will have the greatest impact on pollution problems and that will most benefit those who depend on the Gulf's resources. The estimates are useful in setting priorities regarding how to manage and protect individual rivers and estuaries in the study area, and can contribute to a better understanding of the impact that point and nonpoint source discharges have on water quality.

The inventory can also be used to assist in the design of joint marine monitoring efforts, aid in the implementation of pollution abatement programs such as the Coastal Nonpoint Pollution Control Programs required by Section 6217 of the U.S. Coastal Zone Management Act Reauthorization Amendments of 1990, and support regional planning efforts. In the future, it may be possible to link the inventory to habitat suitability assessments to evaluate the impact of changes in pollutant loadings on estuarine ecosystems.

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The point, nonpoint, and upstream source data are available from the download site (see DATA PRODUCTS). Access the readme document for a description of the ascii files.

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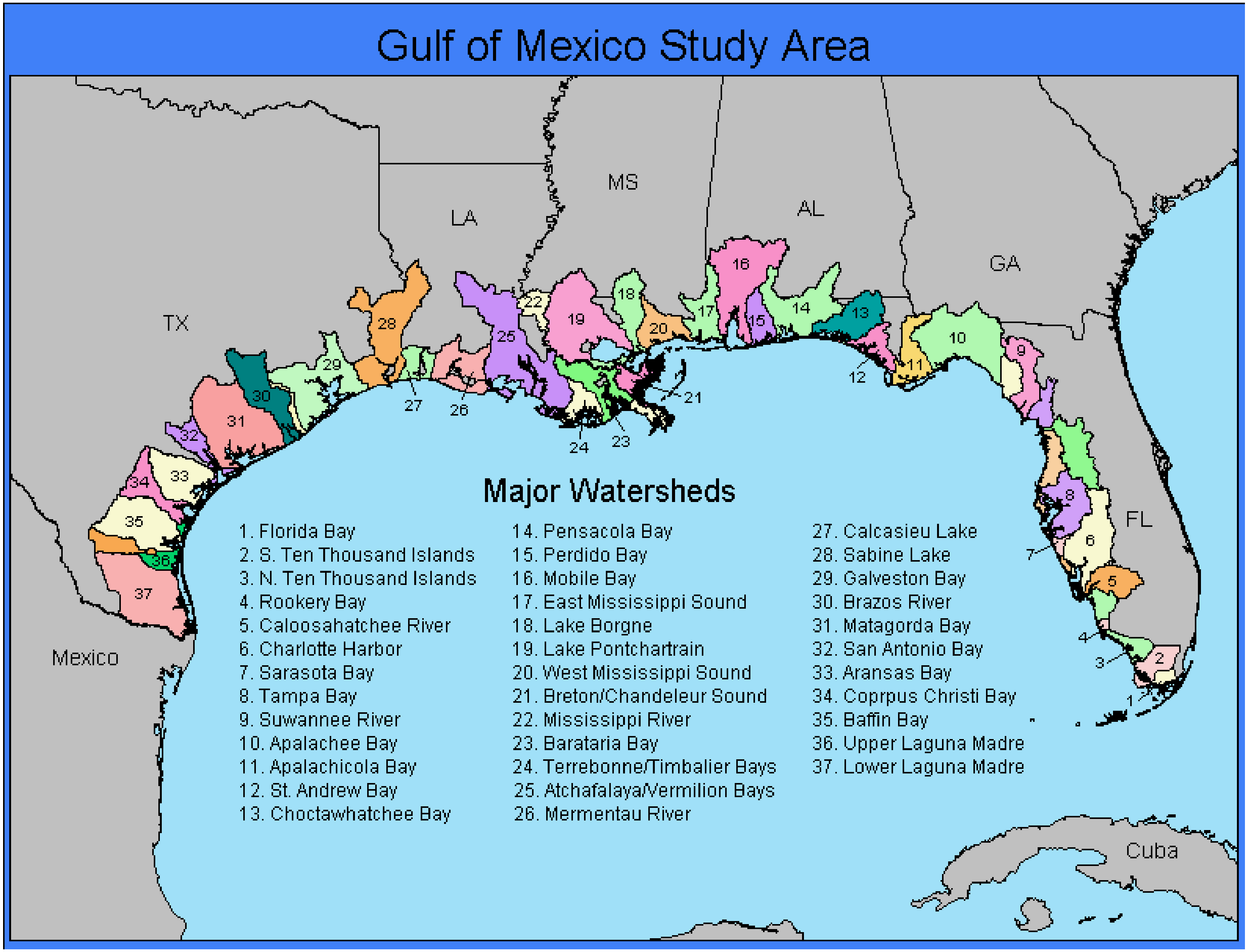

Stretching from the turquoise waters of the Florida Keys in the east to the mouth of the Rio Grande in the west, the Gulf of Mexico Watershed Study Area covers 93,177 square miles across six states. The Gulf of Mexico's U.S. coastline is approximately 1,631 miles long. There are 37 major watersheds (EDA) and 58 minor coastal drainage areas (CDA), 169 counties, 90 U.S. Geological Survey (U.S.G.S) Hydrologic Cataloging Units (huc), and 146 SWAT modeling units (subbasins) or uniques (huc/watershed intersection polygon) in the study area.

Gulf waters are among the most productive, yielding more than 1.7 billion pounds of fish and shellfish annually with a dockside value of $3.6 billion in the United States and total consumer expenditures exceeding $ 26 billion. Ninety five percent of the Gulf fish and shellfish species that commercial and recreational fishermen catch depend on estuarine habitats at one or more critical stage in their lives. A number of factors have recently placed the health of Gulf estuaries at risk including:

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- freshwater inflow diversions for human activities,
- toxic "red tides" and "brown tides" that result in massive fish kills, and
- hypoxia (dissolved oxygen concentrations below two parts per million) along the inner continental shelf of Louisiana (1).

The Need to Characterize Land-Based Activities

Excessive nutrients entering the estuarine and coastal waters of the Gulf of Mexico from land sources are detrimental to the health of these waters. An understanding of the sources, location and quantity of these nutrient discharges is fundamental to developing effective control strategies for mitigating these impacts. While studies characterizing the source and magnitude of nutrient discharges may exist for individual watersheds or portions of watersheds in the Gulf region, this information has not been compiled into a single database and evaluated with regard to the primary factors affecting nutrient loadings to the Gulf of Mexico coastal watersheds. There is a need to have estimates of nutrient loads calculated on a comparable basis to identify data needs and develop a comprehensive point and nonpoint source monitoring strategy to meet the future needs of the Gulf of Mexico program. As land-use intensifies, so do the effects of nonpoint source pollution. Nonpoint sources of pollution to the Gulf represent the greatest threat to the nearshore environment because of their chronic character, their cumulative effect, and their difficulty to apply control abatement.

Point sources of pollution come from municipal sewage treatment plants and industrial plants, such as pulp and paper mills, organic and inorganic chemical products, petroleum refining, and pesticides and mineral mining, all of which are found along the Gulf.

The Gulf of Mexico Program, a partnership for action, has recognized the problem of increasing pressure on the ecosystem's health. The development of a land-based pollution sources inventory to analyze and help better understand the stresses on the ecosystem and to enable environmental managers and policy makers to accurately assess environmental problems and set remedial or regulatory priorities accordingly, is a needed tool to help achieve the Program's major goal which is to protect , restore, and enhance the coastal and marine waters of the Gulf of Mexico and its coastal natural habitats in ways consistent with the economic well being of the region.

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Gulf of Mexico Land-Based Pollution Sources Inventory


Point Sources


Nonpoint Sources


Upstream Sources

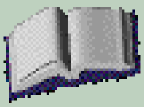
Parameters in the Land-Base Pollution Sources Inventory

Annual, seasonal and monthly discharge estimates for a base year of 1991 are made for 15 parameters of concern based on their effect on water quality and on human health. These parameters are:

1. **FLOW (FLOW)**
2. **BIOCHEMICAL OXYGEN DEMAND (BOD)**
3. **TOTAL SUSPENDED SOLIDS (TSS)**
4. **TOTAL NITROGEN (TN)**
5. **TOTAL PHOSPHORUS (TP)**
6. **TOTAL ARSENIC (As)**
7. **TOTAL CADMIUM (Cd)**
8. **TOTAL CHROMIUM (Cr)**
9. **TOTAL COPPER (Cu)**
10. **TOTAL IRON (Fe)**
11. **TOTAL LEAD (Pb)**
12. **TOTAL MERCURY (Hg)**
13. **TOTAL ZINC (Zn)**
14. **OIL AND GREASE (OG)**
15. **TOTAL FECAL COLIFORM BACTERIA (FCB)**

Gulf of Mexico Land-Based Pollution Sources Inventory

POINT SOURCES OF POLLUTION



Inventory

Results

Challenges

NONPOINT SOURCES OF POLLUTION

Inventory

Results

Upstream Sources of Pollution

Upstream sources in the Gulf are rivers or streams that originate outside of an Estuarine Drainage Area (EDA) and flow into the Gulf of Mexico study area. These bodies of water enter an estuary and contribute to the total pollutant load eventually discharged to the ocean. Upstream sources carry pollutants from both urban and non-urban areas. The major pollutants from these sources include: suspended sediments, pesticides, nutrients (nitrogen and phosphorus), chlorinated hydrocarbons (Polychlorinated biphenyls), heavy metals (arsenic, cadmium, copper, chromium, iron, lead, mercury, silver, zinc), petroleum hydrocarbons (oil and grease), and fecal coliform bacteria.

Pollutant loads at the NASQAN stations were estimated using the Load Estimation (LOADEST) regression model* created by the United States Geological Survey (USGS). These estimates then, were areally prorated to the upstream sources point of entrance to the study area. LOADEST makes use of two input databases. The first provides an historical record (1974 - present) of pollutant concentrations for ten metals, nutrients, and sediment. The second incorporates measured daily flow for 1991 (base year). LOADEST applies both databases to the following general loading equation to produce statistics and pollutant discharge estimates:

$\ln L = B_0 + (B_1 * \ln Q) + (B_2 * \ln Q^2) + (B_3 * \sin 2\pi\ T) + (B_4 * \cos 2\pi\ T) + (B_5 * T)$, where

L = Pollutant Load (mass/time)

Q = Stream Flow (volume/time)

C = Pollutant Concentration (mass/volume)

T = Time (Julian Days)

B_1 - B_5 = Regression Coefficients.

There are 33 rivers in the 1991 Gulf of Mexico Upstream Sources database. Listed below are some of the top dischargers in the inventory.

Top three dischargers by annual Flow:

1. Mississippi River (152,633,770 Million Gallons)

2. Red River (61,551,562 Million Gallons)

3. Tombigbee River (10,690,784 Million Gallons)

Top three dischargers by Total Nitrogen:

1. Mississippi River (2,836,050,000 Pounds)

2. Red River (1,068,797,413 Pounds)

3. Tombigbee River (87,268,156 Pounds)

Top three dischargers by Total Phosphorus:

1. Red River (89,066,451 Pounds)

2. Tombigbee River (8,763,329 Pounds)

3. Brazos River (5,358,704 Pounds)

* For a more detailed description of the load estimation regression model, please refer to: ESTIMATING MEAN CONSTITUENT LOADS IN RIVERS BY THE RATING-CURVE AND FLOW-DURATION, RATING-CURVE METHODS, Charles G. Crawford, PhD Thesis, School of Public and Environmental Affairs, Indiana University, December 1996.

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Next Steps

There are several possible improvements that could be made to the Gulf of Mexico Land-Based Pollution Sources Inventory as recognized by the project team. These include:

- Incorporating additional data to update estimates for point and nonpoint source pollutant loads to a more recent base year (e.g., 1997);
- Refining information for minor point source facilities;
- Improving spatial resolution (e.g., 14-digit subbasins);
- Completing the upper portion of the watershed (Fluvial Drainage Areas) to obtain point and nonpoint pollutant loading estimates;
- Overlaying other data to improve the utility of the Gulf of Mexico Project (e.g., shellfish closures information to be correlated with pollutant discharges);
- Providing the inventory in several GIS formats; and
- Increasing awareness and access to the inventory (e.g., putting all or a portion of the inventory into a desktop information system to make the data more accessible to a broader group of managers and analysts).

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Contact

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Gulf of Mexico Land-Based Pollution Sources Inventory

Related Publications

Click on a title below to learn more about the publication:

- The National Coastal Pollutant Discharge Inventory: National Point Source Methods Document.
- 50 years of population change along the Nation's coasts, 1960-2010. Coastal trends series, report #2.
- Distribution of fishes and invertebrates in Gulf of Mexico Estuaries, ELMR, report No. 10, Vol I, Data Summaries.
- Meeting the Gulf of Mexico Shellfish Challenge: Using strategic assessment to define strategies @ target watersheds for shellfish restoration.
- NOAA's Coastal Assessment Framework

Gulf of Mexico Land-Based Pollution Sources Inventory

Description of Point Source Ascii Files Available

DELIVERABLE FILES:	
1. g_file1.zip	**Facility File** This zip ascii tab delimited file contains information on the permit number, facility name, location, major/minor designation, and type of activity for major and minor facilities in the watersheds draining to the coastal waters. It can be used as a reference for assessments of the number, location, and type of facilities in the coastal area drainage.
2. g_file2.zip	**Monthly Discharge Monitoring Report (DMR) File** The zip ascii tab delimited file contains up to 12 monthly values for each pipe/pollutant combination for the five reporting requirements (average, minimum, and maximum flow or concentration; average and maximum mass discharge), expressed in the original units from the NPDES permit and in NCPDI standardized units. This information is available for all parameters reported in PCS (over 1,600 pollutant paramters). This file can be used to investigate the actual monitoring values reported by facilities in their monthly compliance monitoring reports.
3. g_file3.zip	**Permit Requirements and Loading File** This zip ascii tab delimited file contains two types of information. The first is the discharge requirements specified in each facility's NPDES permit. A second block of data fields for each record contains the mass discharge estimated for each unique pipe/pollutant combination based on the flow, concentration, and mass values reported in the facility NPDES permit. This file can be used to check the original discharge requirements issued in the facility permit and to investigate estimated loadings based on permit requirements.
4. g_file4.zip	**Discharge Monitoring Report (DMR) Loadings File** This zip ascii tab delimited file contains two types of information - a statistical summary of the monthly self-monitoring conducted by the facility, and an estimate of the daily pollutant load discharged by the facility for each parameter specified in the NPDES permit. This information is available for all parameters reported in PCS (over 1,600 pollutant parameters).

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[5. g_file5.zip]	**Typical Pollutant Concentration (TPC) Loadings File** This zip ascii tab delimited file provides pollutant loading estimates using the National Coastal Pollutant Discharge Inventory TPC Matrix. Flows are from every available source. Flows and pollutant load basis codes are maintained along all assignment made to the record in order to obtain loads.
[6. g_file6.zip]	**Permit, DMR, and Typical Pollutant Concentration (TPC) Loadings File (PIPE LEVEL)** This zip ascii tab delimited file contains daily, seasonal, and annual loading estimates for the 15 pollutant parameters in the NCPDI, along with the estimation basis code. The estimates will be at the pipe level. In addition, the file contains information on assumed operating days, type of pipe discharge, and pollutant concentration associated with the type of discharge activity.
[7. g_file7.zip] Most Useful	**Permit, DMR, and Typical Pollutant Concentration (TPC) Loadings File (FACILITY LEVEL)** This zip ascii tab delimited file summarizes the information in File VI to the facility level. It contains seasonal and annual loading estimates for the 15 pollutantparameters carried in the NCPDI, along with the estimation basis code. It will also contain additional information on facility location and activity merged from the Facility File (File I).
AGGREGATED DATA:	
By Watershed Units:	
[1. eda.txt] Most Useful	Ascii tab delimited file containing 1991 pollutant loads by major watershed (EDA/CDA) for major and minor facilities.
[2. huc.txt]	Ascii tab delimited file containing 1991 pollutant loads by USGS 8-digit hydrologic cataloging unit for major and minor facilities.
[3. uniq.txt]	Ascii tab delimited file containing 1991 pollutant loads by uniques for major and minor facilities.
By Political Units:	
[1. state.txt]	Ascii tab delimited file containing 1991 pollutant loads by state for major and minor facilities.
[2. cnty.txt]	Ascii tab delimited file containing 1991 pollutant loads by county for major and minor facilities.
SUPPORTING DATA:	
[1. tpc_matrix.txt]	Ascii tab delimited file providing typical pollutant concentrations for point sources by discharge category.
[2.typical_flows.txt]	Ascii tab delimited file providing typical flows for point sources by standard industrial category (SIC) code.

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Description of Nonpoint Source Ascii Files Available

DELIVERABLE FILES:	
1.gusta_id.zip	This zip ascii tab delimited file contains general locational information on weather stations.
2.gu_wea.zip	This zip ascii tab delimited file contains daily precipitation (mm) and daily high and low temperatures (degrees centigrades) for weather stations. Period range is from 1989 to 1995.
3.guavgwea.zip	This zip ascii tab delimited file contains an average of daily precipitation (mm) and daily high and low temperatures (degrees centigrades) of ALL weather stations in the modeling unit (unique).
4.gu_rout.zip	This zip ascii delimited file contains the uniques routing scheme. It also provides drainage areas of uniques.
5.gu_sbs.zip Most Useful	This zip ascii tab delimited file contains 1989-1995 nonpoint source pollutant loading estimates and other data related to water, sediment, nutrients, and crops for each virtual basin (land use), by modeling unit (unique) and by month.
6.gu_bsb.zip	This zip ascii tab delimited file contains 1989-1995 nonpoint source pollutant loading estimates and other data related to water, sediment, nutrients, and crops for each modeling unit (unique), by month.
7. gu_rch.zip	This zip ascii tab delimited file reports output for each stream channel routing reach by month for the period 1989-1995.
AGGREGATED DATA:	
By Watershed Units:	
1. nps_eda1.txt	Ascii tab delimited file containing 1989-1995 pollutant loads by major watershed (EDA/CDA). Data aggregated using the .BSB file. It also provides routed aggregated loads from the .RCH file.
2.nps_eda2.txt Most Useful	Ascii tab delimited file containing 1989-1995 pollutant loads by major watershed (EDA/CDA) and by land use major category. Data aggregated using the .SBS file
3.nps_huc1.txt	Ascii tab delimited file containing 1989-1995 pollutant loads by USGS 8-digit hydrologic cataloging unit. Data aggregated using the .BSB file. It also provides routed aggregated loads from the . RCH file.
4.nps_huc2.txt	Ascii tab delimited file containing 1989-1995 pollutant loads by USGS 8-digit hydrologic cataloging unit and by land use major category. Data aggregated using the .SBS file
5.nps_uni1.txt	Ascii tab delimited file containing 1989-1995 pollutant loads by unique (modeling unit). Data aggegated using the .BSB file. It also provides routed aggregated loads from the .RCH file.

6.nps_uni2.txt	Ascii tab delimited file containing 1989-1995 pollutant loads by unique (modeling unit) and by land use major category. Data aggregated using the .SBS file
By Political Units:	
1.nps_sta1.txt	Ascii tab delimited file containing 1989-1995 pollutant loads by state.
2.nps_cty1.txt	Ascii tab delimited file containing 1989-1995 pollutant loads by county.
SUPPORTING DATA:	
1.gu_crop.txt	This ascii tab delimited file contains general information on crops. The crop parameters include biomass conversion factor, harvest index, optimum and base temperature, maximum leaf area, maximum root depth and several other variables.
2.gu_till.txt	This ascii tab delimited file contains general information on tillage. It provides mixing efficiencies for several tillage operations.
3.gu_fert.txt	This ascii tab delimited file contains general information on fertilizer application rates in kg/ha.

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Description of Upstream Sources Ascii Files Available

DELIVERABLE FILES:	
1. GU_UPSTR.TXT Most Useful	Ascii tab delimited file containing 1991 individual upstream pollutant loads entering the study area at UNIQUES (modeling unit). It also provides the proration factor used to prorate NASQAN pollutant loading estimates to point of entry estimates.
AGGREGATED DATA:	
By Watershed Units:	
1. GU_U_EDA.TXT	Ascii tab delimited file containing 1991 aggregated upstream pollutant loads entering to Estuarine Drainage Areas (EDAs) or Coastal Drainage Areas (CDAs).

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Description of Digital Geographic Files Available

DELIVERABLE FILES:	
1.Gulf_of_Mexico_Study_Area.zip	This zip file contains the component files necessary to build a geographic shapefile in ArcView 3.1 of the Gulf of Mexico study area watersheds. The map projection attributes are: projection=geographic; units=decimal degrees; and datum=nad83

Watersheds in the Gulf of Mexico Study Area

Watershed Name	EDA Code	CDA Code	Land Area (sq. mi.)	Water Area (sq. mi.)
Florida Bay	G010x		349	642
South Ten Thousand Islands	G020x		1185	87
CDA G025 (Everglades)		G025x	0	865
North Ten Thousand Islands	G030x		751	151
CDA G033 (Big Cypress Swamp)		G033x	1	159
CDA G036 (Big Cypress Swamp)		G036x	0	88
Rookery Bay	G040x		128	13
CDA G045 (Big Cypress Swamp)		G045x	673	472
Charlotte Harbor	G050a		1374	26
Charlotte Harbor	G050w		3141	194
CDA G053 (Charlotte Harbor)		G053x	44	703
CDA G056 (Sarasota Bay)		G056x	116	343
Sarasota Bay	G060x		252	48
CDA G065 (Sarasota Bay)		G065x	3	521
Tampa Bay	G070x		2202	348
CDA G072 (Tampa Bay)		G072x	1	159
CDA G074 (Crystal-Pithlachascotee)		G074x	1156	1552
CDA G076 (Withlachoochee)		G076x	1982	33
CDA G078 (Waccasassa)		G078x	822	232
Suwannee River	G080x		1764	64
CDA G083 (Waccasassa)		G083x	2	518
CDA G086 (Econfina-Steinhatchee)		G086x	790	368
Apalachee Bay	G090x		4598	684
CDA G093 (Apalachee Bay-St. Marks)		G093x	0	528
CDA G095 (New)		G095x	8	135
Apalachicola Bay	G100x		1670	229
CDA G102 (Apalachicola Bay)		G102x	12	803
CDA G105 (New)		G105x	1	68
CDA G108 (St. Andrew-St. Joseph Bays)		G108x	74	668

St. Andrew Bay	G110x		1041	97
CDA G112 (St. Andrew-St. Joseph Bays)		G112x	0	109
CDA G115 (St. Andrew-St. Joseph Bays)		G115x	45	468
CDA G118 (Choctawatchee Bay)		G118x	22	278
Choctawhatchee Bay	G120x		2098	131
CDA G123 (Choctawatchee Bay)		G123x	0	29
CDA G125 (Pensacola Bay)		G125x	6	710
Pensacola Bay	G130x		3337	184
CDA G133 (Pensacola Bay)		G133x	0	9
CDA G135 (Perdido Bay)		G135x	2	252
Perdido Bay	G140x		1131	50
CDA G143 (Perdido Bay)		G143x	0	10
CDA G145 (Perdido Bay)		G145x	22	433
Mobile Bay	G150x		4443	416
CDA G155 (Mississippi Coastal)		G155x	3	303
East Mississippi Sound	G160x		1789	253
CDA G165 (Mississippi Coastal)		G165x	1	184
Lake Borgne	G170a		2100	287
Lake Borgne	G170b		4703	725
Lake Borgne	G170w		1564	610
CDA G175 (Mississippi Coastal)		G175x	3	256
Breton/Chandeleur Sound	G180x		830	1661
CDA G185 (Eastern Louisiana Coastal)		G185x	3	847
CDA G188 (Eastern Louisiana Coastal)		G188x	0	224
Mississippi River	G190x		1433	379
CDA G193 (Lower Mississippi-New Orleans)		G193x	0	738
CDA G195 (East Central Louisiana Coastal)		G195x	1	536
Barataria Bay	G200x		1847	329
CDA G205 (East Central Louisiana Coastal)		G205x	6	456
Terrebonne/Timbalier Bays	G210x		1017	487
CDA G215 (West Central Louisiana Coastal)		G215x	5	957
Atchafalaya/Vermilion Bays	G220x		6435	860
CDA G222 (West Central Louisiana Coastal)		G222x	8	312
CDA G223 (Vermilion)		G223x	11	620
CDA G226 (Mermentau)		G226x	41	914
Mermentau River	G230x		2152	174
CDA G235 (Mermentau)		G235x	0	24

Calcasieu Lake	G240x		933	100
CDA G245 (Lower Calcasieu)		G245x	19	633
Sabine Lake	G250x		4703	102
CDA G255 (Sabine Lake)		G255x	5	497
Galveston Bay	G260x		3880	562
CDA G262 (East Galveston Bay)		G262x	16	423
CDA G265 (West Galveston Bay)		G265x	15	477
CDA G268 (Austin-Oyster)		G268x	371	344
Brazos River	G270x		2808	5
CDA G273 (San Bernard)		G273x	0	67
CDA G276 (East Matagorda)		G276x	2	288
Matagorda Bay	G280x		5423	430
CDA G283 (East Matagorda Bay)		G283x	6	319
CDA G286 (Central Matagorda Bay)		G286x	5	443
San Antonio Bay	G290x		1323	227
CDA G295 (East San Antonio Bay)		G295x	28	511
Aransas Bay	G300x		2479	202
CDA G305 (Aransas)		G305x	13	235
Corpus Christi Bay	G310x		1734	220
CDA G313 (South Corpus Christi Bay)		G313x	6	264
CDA G316 (North Corpus Christi Bay)		G316x	17	358
Upper Laguna Madre	G320a		3295	92
Upper Laguna Madre	G320w		790	228
CDA G325 (Central Laguna Madre)		G325x	9	455
Lower Laguna Madre	G330x		5083	505
CDA G332 (Central Laguna Madre)		G332x	5	316
CDA G335 (South Laguna Madre)		G335x	3	496
CDA G338 (South Laguna Madre)		G338x	1	108
Rio Grande		G339x	87	18

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Counties in the Gulf of Mexico Study Area

FIPS	County	1990 Population	County Area (sq. mi.) in Study Area	Percent County in Study Area
01003	Baldwin County	98280	5597	100
01023	Choctaw County	16018	1615	5
01025	Clarke County	27240	3021	84
01031	Coffee County	40240	1358	2
01035	Conecuh County	14054	2188	8
01039	Covington County	36478	2211	52
01041	Crenshaw County	13635	1358	4
01053	Escambia County	35518	3931	43
01061	Geneva County	23647	1548	22
01069	Houston County	81331	1548	1
01097	Mobile County	378643	4215	100
01099	Monroe County	23968	2188	90
01129	Washington County	16694	3592	96
01131	Wilcox County	13568	1406	5
12001	Alachua County	181596	822	13
12005	Bay County	126994	2707	99
12013	Calhoun County	11011	2139	35
12015	Charlotte County	110975	4673	99
12017	Citrus County	93515	3959	100
12021	Collier County	152099	2765	33
12023	Columbia County	42613	1541	3
12025	Dade County	1937094	2260	53
12027	DeSoto County	23865	3139	100
12029	Dixie County	10585	2483	100
12033	Escambia County	262798	2265	100
12037	Franklin County	8967	3212	100
12039	Gadsden County	41105	2618	100
12041	Gilchrist County	9667	2363	56
12043	Glades County	7591	3638	31
12045	Gulf County	11504	2253	86

12049	Hardee County	19499	2827	100
12051	Hendry County	25773	2047	41
12053	Hernando County	101115	3137	100
12055	Highlands County	68432	2264	8
12057	Hillsborough County	834054	5267	100
12059	Holmes County	15778	1548	95
12063	Jackson County	41375	3686	21
12065	Jefferson County	11296	2146	100
12067	Lafayette County	5578	3261	100
12069	Lake County	152104	1982	15
12071	Lee County	335113	2405	100
12073	Leon County	192493	2682	100
12075	Levy County	25923	5576	85
12077	Liberty County	5569	3150	100
12079	Madison County	16569	3455	73
12081	Manatee County	211707	4186	100
12083	Marion County	194833	2803	20
12087	Monroe County	78024	2285	87
12091	Okaloosa County	143776	3134	100
12101	Pasco County	281131	4326	100
12103	Pinellas County	851659	1684	100
12105	Polk County	405382	5565	60
12113	Santa Rosa County	81608	3343	99
12115	Sarasota County	277776	3865	100
12119	Sumter County	31577	1982	99
12121	Suwannee County	26780	1541	80
12123	Taylor County	17111	4245	100
12129	Wakulla County	14202	2682	100
12131	Walton County	27760	4563	92
12133	Washington County	16919	2589	98
13027	Brooks County	15398	985	15
13087	Decatur County	25511	2618	30
13131	Grady County	20279	2682	22
13253	Seminole County	9010	1097	0
13275	Thomas County	38986	3667	46
22001	Acadia Parish	55882	2152	24
22003	Allen Parish	21226	2182	0
22005	Ascension Parish	58214	5838	100

22007	Assumption Parish	22753	3128	100
22009	Avoyelles Parish	39159	3869	58
22011	Beauregard Parish	30083	2652	22
22019	Calcasieu Parish	168134	5737	56
22023	Cameron Parish	9260	6730	100
22029	Concordia Parish	20828	215	0
22033	East Baton Rouge Parish	380105	2766	100
22037	East Feliciana Parish	19211	2766	100
22039	Evangeline Parish	33274	2182	33
22045	Iberia Parish	68297	6445	100
22047	Iberville Parish	31049	5678	47
22051	Jefferson Parish	448306	2492	100
22053	Jefferson Davis Parish	30722	2152	58
22055	Lafayette Parish	164762	3436	100
22057	Lafourche Parish	85860	4156	100
22063	Livingston Parish	70526	3225	100
22071	Orleans Parish	496938	2486	100
22075	Plaquemines Parish	25575	3214	100
22077	Pointe Coupee Parish	22540	1902	54
22079	Rapides Parish	131556	2182	48
22085	Sabine Parish	22646	2652	19
22087	St. Bernard Parish	66631	1489	100
22089	St. Charles Parish	42437	3334	100
22091	St. Helena Parish	9874	3367	100
22093	St. James Parish	20879	2695	100
22095	St. John the Baptist Parish	39996	2695	100
22097	St. Landry Parish	80331	7305	82
22099	St. Martin Parish	43978	6434	100
22101	St. Mary Parish	58086	6453	100
22103	St. Tammany Parish	144508	3569	95
22105	Tangipahoa Parish	85709	2841	98
22109	Terrebonne Parish	96982	3997	100
22113	Vermilion Parish	50055	3477	100
22115	Vernon Parish	61961	2652	43
22117	Washington Parish	43185	2472	52
22121	West Baton Rouge Parish	19419	905	14
22125	West Feliciana Parish	12915	2592	97
28005	Amite County	13328	3367	86

28037	Franklin County	8377	1862	3
28039	George County	16673	1646	77
28041	Greene County	10220	1646	8
28045	Hancock County	31760	3325	100
28047	Harrison County	165365	1551	100
28059	Jackson County	115243	3339	93
28073	Lamar County	30424	3317	33
28085	Lincoln County	30278	2637	4
28091	Marion County	25544	1770	78
28109	Pearl River County	38714	3317	93
28111	Perry County	10865	614	5
28113	Pike County	36882	775	51
28131	Stone County	10750	1547	34
28147	Walthall County	14352	1770	24
28153	Wayne County	19517	1031	0
28157	Wilkinson County	9678	2551	27
48005	Angelina County	69884	1122	7
48007	Aransas County	17892	1753	100
48015	Austin County	19832	2682	99
48025	Bee County	25135	3213	100
48039	Brazoria County	191707	4959	100
48047	Brooks County	8204	5222	77
48057	Calhoun County	19053	4058	100
48061	Cameron County	260067	2615	100
48071	Chambers County	20088	3485	100
48089	Colorado County	18383	4749	78
48123	DeWitt County	18840	2780	62
48131	Duval County	12918	4633	67
48149	Fayette County	20095	3920	19
48157	Fort Bend County	225421	5041	100
48167	Galveston County	217399	1504	100
48175	Goliad County	5980	2673	60
48177	Gonzales County	17205	1941	1
48199	Hardin County	41320	1122	11
48201	Harris County	2818199	2241	72
48215	Hidalgo County	382921	5170	94
48239	Jackson County	13039	4092	100
48241	Jasper County	31102	3774	81

48245	Jefferson County	239397	2658	93
48247	Jim Hogg County	5109	2559	51
48249	Jim Wells County	37679	4633	97
48255	Karnes County	12455	3406	6
48261	Kenedy County	460	5237	96
48273	Kleberg County	30274	4112	100
48285	Lavaca County	18690	3125	99
48291	Liberty County	52726	2583	69
48297	Live Oak County	9556	2190	71
48311	McMullen County	817	1338	3
48321	Matagorda County	36928	2437	100
48351	Newton County	13569	2652	90
48355	Nueces County	291145	5792	100
48361	Orange County	80509	4703	100
48391	Refugio County	7976	3621	95
48407	San Jacinto County	16372	815	2
48409	San Patricio County	58749	2911	100
48427	Starr County	40518	5083	22
48457	Tyler County	16646	1122	40
48469	Victoria County	74361	3057	96
48473	Waller County	23390	3106	60
48477	Washington County	26154	1634	27
48479	Webb County	133239	2007	1
48481	Wharton County	39955	4737	100
48489	Willacy County	17705	5092	100

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USGS Cataloging Units in the Gulf of Mexico Study Area

Cataloging Unit	Hydrologic Cataloging Unit Name	Cataloging Unit Area (sq. mi.)
03090202	EVERGLADES. FLORIDA	1669
03090203	FLORIDA BAY-FLORIDA KEYS	26
03090204	BIG CYPRESS SWAMP. FLORIDA	1393
03090205	CALOOSAHATCHEE. FLORIDA	1374
03100101	PEACE. FLORIDA	2264
03100102	MYAKKA. FLORIDA	563
03100103	CHARLOTTE HARBOR. FLORIDA	357
03100201	SARASOTA BAY. FLORIDA	371
03100202	MANATEE. FLORIDA	355
03100203	LITTLE MANATEE. FLORIDA	222
03100204	ALAFIA. FLORIDA	437
03100205	HILLSBOROUGH. FLORIDA	661
03100206	TAMPA BAY. FLORIDA	528
03100207	CRYSTAL-PITHLACHASCOTEE. FLORIDA	1156
03100208	WITHLACOOCHEE. FLORIDA	1982
03110101	WACCASASSA. FLORIDA	898
03110102	ECONFINA-STEINHATCHEE. FLORIDA	1869
03110103	AUDCILLA. FLORIDA	985
03110205	LOWER SUWANNEE. FLORIDA	1541
03120001	APALACHEE BAY-ST. MARKS. FLORIDA	1162
03120003	LOWER OCHLOCKONEE. FLORIDA	1522
03130011	APALACHIOLA. FLORIDA, GEORGIA	1097
03130013	NEW. FLORIDA	541
03130014	APALACHIOLA BAY. FLORIDA	52
03140101	ST. ANDRWEW-ST. JOSEPH BAYS. FLORIDA	1160
03140102	CHOCTAWHATCHEE BAY. FLORIDA	572
03140103	YELLOW. ALABAMA, FLORIDA	1358
03140104	BLACKWATER. ALABAMA, FLORIDA	852
03140105	PENSACOLA BAY. FLORIDA	352
03140106	PERDIDO. ALABAMA, FLORIDA	891

03140107	PERDIDO BAY. ALABAMA, FLORIDA	263
03140203	LOWER CHOCTAWHATCHEE. ALABAMA, FLORIDA	1548
03140305	ESCAMBIA. ALABAMA, FLORIDA	782
03150204	LOWER ALABAMA. ALABAMA	1406
03160203	LOWER TOMBIGBEE. ALABAMA	1615
03160204	MOBILE-TENSAW. ALABAMA	946
03160205	MOBILE BAY. ALABAMA	477
03170006	PASCAGOULA. MISSISSIPPI	614
03170008	ESCATAWPA. ALABAMA, MISSISSIPPI	1031
03170009	MISSISSIPPI COASTAL. ALABAMA, MISSISSIPPI	1706
03180004	LOWER PEARL. LOUISIANA, MISSISSIPPI	1770
08070100	LOWER MISSISSIPPI-BATON ROUGE. LOUISIANA	215
08070201	BAYOU SARA-THOMPSON. LOUISIANA, MISSISSIPPI	689
08070202	AMITE. LOUISIANA, MISSISSIPPI	1862
08070203	TICKFAW. LOUISIANA, MISSISSIPPI	731
08070204	LAKE MAUREPAS. LOUISIANA	633
08070205	TANGIPAHOA. LOUISIANA, MISSISSIPPI	775
08080101	ATCHAFALAYA. LOUISIANA	1687
08080102	BAYOU TECHE. LOUISIANA	2182
08080103	VERMILLION. LOUISIANA	1295
08080202	MERMENTAU. LOUISIANA	2193
08080202	UPPER ST. FRANCIS. MISSOURI	2193
08080206	LOWER CALCASIEU. LOUISIANA	952
08090100	LOWER MISSISSIPPI-NEW ORLEANS. LOUISIANA	317
08090201	LIBERTY BAYOU-TCHEFUNCTA. LOUISIANA	702
08090202	LAKE PONTCHARTRAIN. LOUISIANA	1
08090203	EASTERN LOUISIANA COASTAL. LOUISIANA	1176
08090301	EAST CENTRAL LOUISIANA COASTAL. LOUISIANA	2061
08090302	WEST CENTRAL LOUISIANA COASTAL. LOUISIANA	2310
12010005	LOWER SABINE. LOUISIANA, TEXAS	2652
12020003	LOWER NECHES. TEXAS	1122
12030203	LOWER TRINITY. TEXAS	815
12040104	BUFFALO-SAN JACINTO. TEXAS	1102
12040201	SABINE LAKE. LOUISIANA, TEXAS	933
12040202	EAST GALVESTON BAY. TEXAS	602
12040203	NORTH GALVESTON BAY. TEXAS	253
12040204	WEST GALVESTON BAY. TEXAS	902

12040205	AUSTIN-OYSTER. TEXAS	608
12070104	LOWER BRAZOS. TEXAS	1634
12090302	LOWER COLORADO. TEXAS	677
12090401	SAN BERNARD. TEXAS	1049
12090402	EAST MATAGORDA BAY. TEXAS	788
12100101	LAVACA. TEXAS	896
12100102	NAVIDAD. TEXAS	1390
12100204	LOWER GUADALUPE. TEXAS	1045
12100401	CENTRAL MATAGORDA BAY. TEXAS	972
12100402	WEST MATAGORDA BAY. TEXAS	838
12100403	EAST SAN ANTONIO BAY. TEXAS	210
12100404	WEST SAN ANTONIO BAY. TEXAS	96
12100405	ARANSAS BAY. TEXAS	621
12100406	MISSION. TEXAS	1023
12100407	ARANSAS. TEXAS	851
12110111	LOWER NUECES. TEXAS	1338
12110201	NORTH CORPUS CHRISTI BAY. TEXAS	113
12110202	SOUTH CORPUS CHRISTI BAY. TEXAS	285
12110203	NORTH LAGUNA MADRE. TEXAS	151
12110204	SAN FERNANDO. TEXAS	1288
12110205	RAFFIN BAY. TEXAS	2007
12110207	CENTRAL LAGUNA MADRE. TEXAS	3230
12110208	SOUTH LAGUNA MADRE. TEXAS	2528
13090002	LOWER RIO GRANDE. TEXAS	87

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Uniques in the Gulf of Mexico Study Area

Unique	Unique Name	Land Area (sq. mi.)	Water Area (sq. mi.)
336	Florida Bay (336)	324	106
337	Florida Bay (337)	26	536
338	South Ten Thousand Islands (338)	1185	87
339	CDA G025 - Everglades (339)	0	865
340	North Ten Thousand Islands (340)	161	17
342	North Ten Thousand Islands (342)	590	133
343	CDA G033 - Big Cypress Swamp (343)	1	159
344	CDA G036 - Big Cypress Swamp (344)	0	88
345	Rookery Bay (345)	128	13
346	CDA G045 - Big Cypress Swamp (346)	673	472
348	Charlotte Harbor (348)	1374	26
347	Charlotte Harbor (347)	2	1
349	Charlotte Harbor (349)	2264	11
350	Charlotte Harbor (350)	563	7
351	Charlotte Harbor (351)	312	174
352	CDA G053 - Charlotte Harbor (352)	44	703
353	CDA G056 - Sarasota Bay (353)	116	343
354	Sarasota Bay (354)	252	48
355	CDA G065 - Sarasota Bay (355)	3	521
356	Tampa Bay (356)	355	12
357	Tampa Bay (357)	222	0
358	Tampa Bay (358)	437	2
359	Tampa Bay (359)	661	0
360	Tampa Bay (360)	527	334
361	CDA G072 - Tampa Bay (361)	1	159
362	CDA G074 - Crystal-Pithlachascotee (362)	1156	1552
363	CDA G076 - Withlachoochee (363)	1982	33
364	CDA G078 - Waccasassa (364)	822	232
365	Suwannee River (365)	74	20
366	Suwannee River (366)	149	27

371	Suwannee River (371)	1541	17
373	CDA G083 - Waccasassa (373)	2	518
374	CDA G086 - Econfina-Steinhatchee (374)	790	368
375	Apalachee Bay (375)	929	351
376	Apalachee Bay (376)	985	1
377	Apalachee Bay (377)	1162	318
379	Apalachee Bay (379)	1520	11
380	Apalachee Bay (380)	2	4
381	CDA G093 - Apalachee Bay-St. Marks (381)	0	528
382	CDA G095 - New (382)	8	135
393	Apalachicola Bay (393)	1097	16
395	Apalachicola Bay (395)	532	53
396	Apalachicola Bay (396)	41	160
397	CDA G102 - Apalachicola Bay (397)	12	803
398	CDA G105 - New (398)	1	68
399	CDA G108 - St. Andrew-St. Joseph Bays (399)	74	668
400	St. Andrew Bay (400)	1041	97
401	CDA G112 - St. Andrew-St. Joseph Bays (401)	0	109
402	CDA G115 - St. Andrew-St. Joseph Bays (402)	45	468
403	CDA G118 - Choctawatchee Bay (403)	22	278
404	Choctawhatchee Bay (404)	549	130
405	Choctawhatchee Bay (405)	1	0
408	Choctawhatchee Bay (408)	1548	2
409	CDA G123 - Choctawatchee Bay (409)	0	29
410	CDA G125 - Pensacola Bay (410)	6	710
411	Pensacola Bay (411)	1358	0
412	Pensacola Bay (412)	852	0
413	Pensacola Bay (413)	344	184
418	Pensacola Bay (418)	782	0
419	CDA G133 - Pensacola Bay (419)	0	9
420	CDA G135 - Perdido Bay (420)	2	252
421	Perdido Bay (421)	891	1
422	Perdido Bay (422)	239	49
423	CDA G143 - Perdido Bay (423)	0	10
424	CDA G145 - Perdido Bay (424)	22	433
430	Mobile Bay (430)	946	22
433	Mobile Bay (433)	1406	0

434	Mobile Bay (434)	1615	0
435	Mobile Bay (435)	477	395
436	CDA G155 - Mississippi Coastal (436)	3	303
442	East Mississippi Sound (442)	614	5
444	East Mississippi Sound (444)	1031	0
445	East Mississippi Sound (445)	143	248
446	CDA G165 - Mississippi Coastal (446)	1	184
448	Lake Borgne (448)	8	6
452	Lake Borgne (452)	1770	5
461	Lake Borgne (461)	322	276
454	Lake Borgne (454)	1862	0
455	Lake Borgne (455)	731	1
456	Lake Borgne (456)	0	631
457	Lake Borgne (457)	775	0
458	Lake Borgne (458)	702	0
483	Lake Borgne (483)	633	93
447	Lake Borgne (447)	1547	489
459	Lake Borgne (459)	17	122
462	CDA G175 - Mississippi Coastal (462)	3	256
463	Breton/Chandeleur Sound (463)	1	38
464	Breton/Chandeleur Sound (464)	830	1622
465	CDA G185 - Eastern Louisiana Coastal (465)	3	847
466	CDA G188 - Eastern Louisiana Coastal (466)	0	224
468	Mississippi River (468)	215	20
469	Mississippi River (469)	689	0
470	Mississippi River (470)	317	278
471	Mississippi River (471)	4	39
472	Mississippi River (472)	207	41
473	CDA G193 - Lower Mississippi-New Orleans (473)		738
474	CDA G195 - East Central Louisiana Coastal (474)	1	536
475	Barataria Bay (475)	1847	329
476	CDA G205 - East Central Louisiana Coastal (476)	6	456
477	Terrebonne/Timbalier Bays (477)	1017	487
478	CDA G215 - West Central Louisiana Coastal (478)	5	957
481	Atchafalaya/Vermilion Bays (481)	2182	27
482	Atchafalaya/Vermilion Bays (482)	1687	290
484	Atchafalaya/Vermilion Bays (484)	1284	472

485	Atchafalaya/Vermilion Bays (485)	1281	71
486	CDA G222 - West Central Louisiana Coastal (486)	8	312
487	CDA G223 - Vermilion (487)	11	620
488	CDA G226 - Mermentau (488)	41	914
490	Mermentau River (490)	2152	174
491	CDA G235 - Mermentau (491)	0	24
495	Calcasieu Lake (495)	933	100
496	CDA G245 - Lower Calcasieu (496)	19	633
501	Sabine Lake (501)	2652	3
504	Sabine Lake (504)	1122	5
509	Sabine Lake (509)	928	94
510	CDA G255 - Sabine Lake (510)	5	497
514	Galveston Bay (514)	815	8
518	Galveston Bay (518)	1102	14
519	Galveston Bay (519)	586	191
520	Galveston Bay (520)	253	132
521	Galveston Bay (521)	886	203
522	Galveston Bay (522)	237	15
523	CDA G262 - East Galveston Bay (523)	16	423
524	CDA G265 - West Galveston Bay (524)	15	477
525	CDA G268 - Austin-Oyster (525)	371	344
530	Brazos River (530)	1634	3
531	Brazos River (531)	1048	2
532	Brazos River (532)	126	0
533	CDA G273 - San Bernard (533)	0	67
534	CDA G276 - East Matagorda (534)	2	288
537	Matagorda Bay (537)	677	1
538	Matagorda Bay (538)	654	55
539	Matagorda Bay (539)	896	1
540	Matagorda Bay (540)	1390	0
541	Matagorda Bay (541)	967	310
542	Matagorda Bay (542)	838	62
543	CDA G283 - East Matagorda Bay (543)	6	319
544	CDA G286 - Central Matagorda Bay (544)	5	443
548	San Antonio Bay (548)	1045	1
553	San Antonio Bay (553)	181	169
554	San Antonio Bay (554)	96	56

555	CDA G295 - East San Antonio Bay (555)	28	511
556	Aransas Bay (556)	604	195
557	Aransas Bay (557)	1023	6
558	Aransas Bay (558)	851	2
559	CDA G305 - Aransas (559)	13	235
560	Corpus Christi Bay (560)	4	19
571	Corpus Christi Bay (571)	1338	1
572	Corpus Christi Bay (572)	113	52
573	Corpus Christi Bay (573)	279	149
574	CDA G313 - South Corpus Christi Bay (574)	6	264
575	CDA G316 - North Corpus Christi Bay (575)	17	358
577	Upper Laguna Madre (577)	1288	0
578	Upper Laguna Madre (578)	2007	92
576	Upper Laguna Madre (576)	134	73
579	Upper Laguna Madre (579)	656	155
580	CDA G325 - Central Laguna Madre (580)	9	455
581	Lower Laguna Madre (581)	2559	156
582	Lower Laguna Madre (582)	2524	349
583	CDA G332 - Central Laguna Madre (583)	5	316
584	CDA G335 - South Laguna Madre (584)	3	496
585	CDA G338 - South Laguna Madre (585)	1	108
588	Rio Grande (588)	87	18

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Gulf of Mexico Land-Based Pollution Sources Inventory

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Gulf of Mexico Land-Based Pollution Sources Inventory

Flow

1) General Information
Flow is one of the 15 pollutants for which monthly, seasonal and annual estimates are obtained from point and nonpoint sources. Flow values can be aggregated to a spatial unit (i.e. subbasin, USGS cataloging Unit, watershed, county, etc) of interest.

2) Point Sources Inventory
Two types of flows are distinguished for a facility, Total Flow and Process Flow. Total Flow is the sum of all flows from all pipes. Process Flow is the sum of only process flows (flows originated from production processes) reported in all pipes. If a pipe is a combined pipe discharge (process and once-through cooling water or process and stormwater runoff), process flow is only that quantity to have originated from produccion processes.

If monitoring flow (storet parameters: 50050, 00056, 00058, 74060, 82220, 74020, 50049, 78932, 50047, 78720 or 73776) are not present or are suspected to be in error, flows from several other sources are used, including typical flow values obtained by Standard Classification Codes (SICs). Download typical_flows.txt to see tabular data.

3) Non-Urban Nonpoint Sources Inventory

3a) No Routing Component
Flow (water yield) is estimated by the SWAT model for each virtual basin (landuse) by:

Flow = surface runoff + lateral subsurface flow + groundwater flow

Surface Runoff is predicted by SWAT for daily rainfall by using the Soil Conservation Service (curve number) equation (USDA-SCS, 1972).

$$Q = \frac{(R - 0.2\,s)^2}{R + 0.8\,s}, \quad R > 0.2\,s \qquad (1)$$
$$Q = 0.0, \quad R \le 0.2\,s$$

where Q is the daily runoff, R is the daily rainfall, and s is a retention parameter.

The retention parameter, s, varies (a) among subbasins because soils, land use, management, and slope all vary and (b) with time because of changes in soil water content. The parameter s is related to curve number (CN) by the SCS equation (USDA-SCS, 1972)

$$s = 254\left(\frac{100}{CN} - 1\right) \qquad (2)$$

The constant, 254, in equation 2 gives s in mm. Thus, R and Q are also expressed in mm. CN2--the curve number for moisture condition 2, or average curve number--can be obtained easily for any area by using the SCS hydrology handbook (USDA-SCS, 1972). The handbook tables consider soils, land use, and management. Assuming that the handbook CN2 value is appropriate for a 5% slope, we developed the following equation for adjusting that value for other slopes.

$$CN_{2s} = \frac{1}{3}\left(CN_3 - CN_2\right)\left[1 - 2\exp\left(-13.86\ S\right)\right] + CN_2 \qquad (3)$$

where CN2s is the handbook CN2 value adjusted for slope, CN3 is the curve number for moisture condition 3 (wet), and S is the average slope of the watershed. Values of CN1, the curve number for moisture condition 1 (dry), and CN3 corresponding to CN2 are also tabulated in the handbook. For computing purposes, CN1 and CN3 were related to CN2 with the equations

$$CN_1 = CN_2 - \frac{20\left(100 - CN_2\right)}{100 - CN_2 + \exp\left[2.533 - 0.0636\left(100 - CN_2\right)\right]} \qquad (4)$$

$$CN_3 = CN_2 \exp\left[0.00673\left(100 - CN_2\right)\right] \qquad (5)$$

Fluctuations in soil water content cause the retention parameter to change according to the equation

$$s = s_1\left(1 - \frac{FFC}{FFC + \exp\left[w_1 - w_2\left(FFC\right)\right]}\right) \qquad (6)$$

where s1 is the value of s associated with CN1, FFC is the fraction of field capacity, and w1 and w2 are shape parameters. FFC is computed with the equation

$$FFC = \frac{SW - WP}{FC - WP} \qquad (7)$$

where SW is the soil water content in the root zone, WP is the wilting point water content (1,500 kPa for many soils), and FC is the field capacity water content (33 kPa for many soils).

Values for w1 and w2 are obtained from a simultaneous solution of equation 6 according to the assumptions that s=s2 when FFC=0.6 and s=s3, when (SW-FC)/(PO-FC)=0.5

$$w_1 = \ln\left(\frac{60.}{1. - s_2/s_1} - 60.\right) + 60.\ w_2 \qquad (8)$$

$$w_2 = \frac{\ln\left(\frac{60.}{1. - s_2/s_1} - 60.\right) - \ln\left(\frac{POFC}{1. - s_3/s_1} - POFC\right)}{POFC - 60.} \qquad (9)$$

where s3 is the CN3 retention parameter and the porosity-field capacity ratio POFC is computed with the equation

$$POFC = 100. + 50. \left(\frac{\sum_{\ell=1}^{M} (PO_\ell - FCsub\ell)}{\sum_{\ell=1}^{M} (FC_\ell - WP_\ell)} \right) \qquad (10)$$

where PO is the porosity of soil layer . Equations 8 and 9 assure that CN1 corresponds with the wilting point and that the curve number cannot exceed 100.

The FFC value obtained in equation 7 represents soil water uniformly distributed through the top 1.0 m of soil. Runoff estimates can be improved if the depth distribution of soil water is known. For example, water distributed near the soil surface results in more runoff than the same volume of water uniformly distributed throughout the top meter of soil. Also, a soil surface associated with a uniform distribution of soil water results in more runoff than a soil surface that is dry. Since SWAT estimates water content of each soil layer daily, the depth distribution is available. The effect of depth distribution on runoff is expressed in the depth weighting function

$$FFC^* = \frac{\sum_{\ell=1}^{M} FFC_\ell \frac{Z_\ell - Z_{\ell-1}}{Zsub\ell}}{\sum_{\ell=1}^{M} \frac{Z_\ell - Z_{\ell-1}}{Z_\ell}}, \qquad Z_\ell <= 1.0\, m \qquad (11)$$

where FFC* is the depth weighted FFC value for use in equation 6, Z is the depth in m to the bottom of soil layer , and M is the number of soil layers. Equation 11 performs two functions: (1) it reduces the influence of lower layers because FFC is divided by Z and (2) it gives proper weight to thick layers relative to thin layers because FFC is multiplied by the layer thickness.

There is also a provision for estimating runoff from frozen soil. If the temperature in the second soil layer is less than 0°C, the retention parameter is reduced by using the equation

$$s_f = 0.1\, s \qquad (12)$$

where sf is the retention parameter for frozen ground. Equation 12 increases runoff for frozen soils but allows significant infiltration when soils are dry.

Lateral Subsurface Flow.- The kinematic storage model developed by Sloan et al. (1983) uses the mass continuity equation with the entire soil profile as the control volume. The mass continuity equation in finite difference form for the kinematic storage model is

$$\frac{S_2 - S_1}{t_2 - t_1} = i L - \frac{q_{lat1} + q_{lat2}}{2} \qquad (13)$$

where S is the drainable volume of water stored in the saturated zone m·m-1 (water above field capacity), t is time in h, qlat is the lateral flow in m3·h-1, i is the rate of water input to the saturated zone in m2·h-1, L is the hillslope length in m, and subscripts 1 and 2 refer to the beginning and end of the time step, respectively. The saturated thickness normal to the hillslope, Ho, is

$$H_o = \frac{2\,S}{\Theta_d\,L} \qquad (14)$$

where ÿd is the drainable porosity of the soil. The drainable volume of water stored, S, is updated daily in the watershed model. The lateral flow at the hillslope outlet is given by

$$q_{lat} = H_o\,v\,w \qquad (15)$$

where v is the velocity of flow at the outlet and w is the hillslope width. Velocity at the outlet is estimated from

$$v = K_s \sin(\alpha) \qquad (16)$$

where Ks is the saturated conductivity. Combining equations 14 and 16 into 15 yields

$$q_{lat} = 0.024\,\frac{2\,S\,K_s \sin(\alpha)}{\Theta_d\,L} \qquad (17)$$

where qlat is in mm·d-1, S in m·h-1, ÿ in m·m-1, ÿd in m·m-1, and L in m. If the saturated zone rises above the soil later, water is allowed to flow to the layer above (back to the surface for the upper soil layer). The amount of flow upward is estimated from Ks and the saturated slope length.

$$q_{sat} = \frac{24\,K_s\,L_s}{L} \qquad (18)$$

where qsat is the upward flow in mm·d-1, and Ls is the saturated slope length in m.

Most comprehensive hydrologic models divide the soil profile into multiple layers, and allow for percolation from one soil layer to the next and percolation from the bottom soil layer past the soil profile (as recharge to the shallow aquifer). To account for multiple layers, the model is applied to each soil layer independently starting at the upper layer.

Groundwater Flow.- The main objective of the groundwater model developed for SWAT is to predict the impact of management changes on total water supplies (Arnold and Allen, 1993). The model is intended for general use where extensive field-work to obtain inputs is not feasible. Thus, the groundwater component must use readily available inputs. Also, it must have sophistication and technology similar to those of the other components of the simulation model. A detailed numerical model is not justified for this situation, and thus a relatively simple yet realistic model was developed.

The hydrologic system simulated by SWAT consists of four control volumes that include: the surface, the soil profile or root zone, the shallow aquifer, and the deep aquifer. Contributions to streamflow area surface runoff, lateral flow from the soil profile, and return flow from the shallow aquifer. The percolate from the soil profile is assumed to recharge the shallow aquifer. Once the water percolates to the deep aquifer, it is lost from the shallow aquifer. Once the water percolates to the deep aquifer, it is lost from the simulated system and cannot return. The water balance for the shallow aquifer is

$$Vsa_i = Vsa_{i-1} + Rc - revap - q_{rf} - perc_{gw} - WUsub_{SA} \qquad (19)$$

where Vsq is the shallow aquifer storage, Rc is the recharge, revap is the water flow from the shallow aquifer back to the soil profile, qrf is the return flow, percgw is the percolate to the deep aquifer, WUSA is the water use (withdrawal) from the shallow aquifer, and i is the day. A description of the groundwater component that was incorporated into the SWAT model follows.

Smedema and Rycroft (1983) derived the non-steady-state response of groundwater flow to periodic recharge from Hooghoudt's (1940) stead state formula:

$$q = \frac{8Kd}{L^2} h \qquad (20)$$

where q is the return flow, Kd is the hydraulic conductivity, L is the drain spacing, and h is the water table height. Assuming that the groundwater body (shallow aquifer) is recharged by seepage from stream channels, reservoirs, or the soil profile (rainfall and irrigation), and is depleted by the return flow to the stream, water table fluctuations are estimated using the equation (Smedema and Rycroft, 1983)

$$\frac{dh}{dt} = \frac{Rc - q}{0.8\,\mu} \qquad (21)$$

where Rc is recharge to the shallow aquifer and µ is the specific yield. Further assuming that the variation in return flow with time is also linearly related to the rate of change of the water table height (as in equation 20) yields the equation

$$\frac{dq}{dt} = 10\,\frac{Kd}{\mu\, L_2}\,(RC - q) = \alpha(Rc - q) \qquad (22)$$

where ÿ is the constant of proportionality or the reaction factor. Integration of equation 21 and solution for q gives

$$q_i = q_{i-1}\, e^{-\alpha\Delta t} + Rc(1.0 - e^{-\alpha\Delta t}) \qquad (23)$$

The relationship for water table height is derived by combining equations 20 and 21 to give

$$h_i = h_{i-1}\, e^{-\alpha\Delta t} + \frac{Rc}{0.8\,\mu\,\alpha}(1.0 - e^{-\alpha\Delta t}) \qquad (24)$$

Sangrey et al. (1984) used an equation to estimate the delay time for return flow in a precipitation/ groundwater response model. They used an exponential decay weighting function proposed by Venetis (1969):

$$Rc_i = (1.0 - e^{(-1.0/\delta)})\, Rc_i + e^{(-1.0/\delta)}\, Rc_{i-1} \qquad (25)$$

where is the delay time or drainage time of the aquifer (Sangrey et al., 1984). This equation will affect only the timing of the return flow and not the total volume.

"Revap" is defined as water that travels from the shallow aquifer to the soil profile and is lost to the atmosphere by soil evaporation or plant root uptake. Its volume is estimated from the equations

$$revap = \beta_r ET_{act} \text{ if } revap > revap_{st} \qquad (26)$$

$$revap = 0.0 \text{ if } revap < revap_{st} \qquad (27)$$

where ETact is the actual evapotranspiration occurring in the soil profile, ßr is the revap coefficient, and revapst is the revap storage. Currently, revap is not directly linked to the soil profile water balance; however, a revap storage is established and return flow is not allowed to occur until the revap storage is met.

The water balance for the deep aquifer is

$$Vda_i = Vda_{i-1} + perc_{gw} - WU_{DA} \qquad (28)$$

where Vda is the deep aquifer storage, percgw is the water percolate to the deep aquifer, and WUDA is the water use (withdrawal) from the deep aquifer.

The amount of percolate from the shallow aquifer (recharge to the deep aquifer or deep flow) is

$$perc_{gw} = \beta_p Rc \qquad (29)$$

where ßp is the percolation coefficient.

3b) Routing Component

Reach routing operates on a daily time step and requires no iteration. This makes the model efficient enough for long-term simulations (50-100 years) on large basins. Also, the need for detailed channel cross-section data has been eliminated. Channel input includes the reach length, channel slope, channel depth, channel top width, channel side slope, flood plain slope, channel "n", and flood plain "n". Flow rate and average velocity are calculated using Manning's equation. Travel time is computed by dividing channel length by velocity. These calculations are computed for full channel depth and a depth of 0.1 times the full depth.

Flow in the routing component is the outflow from the reach routing and it is determined by:

$$O_i = SC\,(I_I + S_{i-1}) \qquad (30)$$

where O is outflow in m3, I is inflow in m3, and Si-1 is storage in the reach from the previous day in m3. The storage coefficient, SC, is estimated using the equations (Williams and Hann, 1973):

$$SC = \frac{48}{2\,TT + 24} \qquad (31)$$

Travel time is then related to flow using the non-linear relationship.

$$TT = \chi_1 \, qr^{\chi_2} \qquad (32)$$

where TT is the travel time in h, qr is the flow rate in m3·h-1, and X1 and X2 are parameters determined for each reach when flow is within the channel.

The procedure is repeated for a depth of 1.5 times the full depth. When the flow rate exceeds full channel depth during routing, the relationship becomes:

$$TT = \chi_3 \, qr^{\chi_4} \qquad (33)$$

where X3 and X4 are parameters determined for each reach when flow exceeds full channel flow.

Outflow is then adjusted for transmission losses, evaporation, diversions, and return flow. Storage in the reach is calculated from the balance equation.

$$S_i = S_{i-1} + I_i - O_i - TL - EV + dv + rt \qquad (34)$$

where TL is channel transmission losses in m3, EV is evaporation in m3, dv is diversions in m3, and rt is return flow in m3.

Transmission Losses. Many semiarid watersheds have alluvial channels that abstract large quantities of streamflow (Lane, 1982). The abstractions, or transmission losses, reduce runoff volumes and peak rates as the flood wave travels downstream. Transmission losses are estimated with the equation

$$tl = (k)(DUR)(wp)(CHL) \qquad (35)$$

where tl is channel transmission losses in m3, k is the effective hydraulic conductivity of the channel alluvium in m·h-1, DUR is the flow duration in h, wp is the wetted perimeter in m, and CHL is the channel length in m. Values of k for various alluvium materials can be found in Chapter 19 of the SCS Hydrology Handbook (USDA, 1972).

A short cut method was also developed to determine wp for a given flow rate to eliminate the need for iteration. Again, a non-linear relationship was used.

$$wp = 1.02 \, qr^{0.565} \qquad (36)$$

The parameters values (1.02 and 0.565) were determined by running several hypothetical channels for various flow depths.

Evaporation Losses.- The volume of water in the reach lost to evaporation is:

$$ev = \eta \, (ev_p)(sa_{rch})(DUR) \qquad (37)$$

where &127 is an evaporation coefficient, evp is potential evapotranspiration in m·h-1, sarch is the surface area of the reach in m2, and DUR is the flow duration in h. The surface area is simply

$$sa_{ch} = (CHL)(w) \qquad (38)$$

where CHL is the channel length and w is the channel width at flow depth.

Impoundment Routing.- This component of SWAT was designed to account for the effects of reservoirs, farm ponds, and wetlands on water yield. The relationships used to estimate evaporation and seepage are identical for all three types of impoundments. The water balance equation is

$$VM = VM_o + QI - QO - EV - SEP \qquad (39)$$

where VMO is the volume of the water stored in all impoundments within a subbasin at the beginning of the day, VM is the volume at the end of the day, QI is the inflow during the day, QO is the outflow, EV is the evaporation, SEP is the seepage, and all units are m3. The inflow, QI is composed of surface runoff from the total impoundment drainage area and rainfall on the water surface area.

The evaporation is computed with the equation

$$EV = 10(\eta)(E_o)(SA) \qquad (40)$$

where &127 is an evaporation coefficient (0.6) and SA is the surface area of the impoundment.

Seepage from the impoundment is computed with the equation

$$SEP = 240(SC)(SA) \qquad (41)$$

where SC is the saturated conductivity of the impoundment bed in mm·h 1.

Since impoundment surface area is required for computing evaporation and seepage, a relationship between surface area and volume is necessary. Data from a large number of stock ponds and small reservoirs in Texas and Oklahoma (USDA-SCS, 1957) indicate that surface area can be calculated with the equation

$$SA = \omega_1 (VM)^{\omega_2} \qquad (42)$$

where w1 is a parameter (1.3X10-4) and w2 is a fairly constant parameter (0.9). The SWAT model assumes 2=0.9 and determines w1 for each subbasin using SAmx and VMmx.

For larger reservoirs, the method for estimating w1 and w2 is slightly different. Since the surface areas and volumes for the principal and emergency spillway crest elevations are generally readily available, those values can be used for a simultaneous solution of equation 42. The resulting equations are

$$\omega_2 = \frac{\log SA_E - \log SA_S}{\log VR_E - \log VR_S} \qquad (43)$$

$$\omega_1 = \frac{SA_F}{VR^{\omega_2}} \qquad (44)$$

where SA is the reservoir surface area and subscripts F and S refer to emergency and principal spillway crest elevations, respectively.

Although the relationships used to estimate evaporation and seepage are identical for all impoundments, methods for determining outflow vary considerably. Wetlands may not have outflow. Farm ponds have only a permanent pool storage, while small flood control reservoirs have principal and emergency spillway volumes and surface areas with a given release rate at volumes above the principal spillway. Most large reservoirs are regulated and require different algorithms for simulating operating rules.

For farm ponds, outflow occurs when the volume exceeds the permanent pool storage capacity and is described with the equation

$$\begin{aligned} QO &= VM - VM_{mx}, \quad VM > VMsubmx \\ QO &= 0, \quad VM \le VMsubmx \end{aligned} \qquad (45)$$

where VMmx is the maximum permanent pool storage of all ponds in the subbasin in m3.

Although this component was mainly designed to simulate flow through small reservoirs like those constructed on SCS PL566 projects, it can also be used on larger reservoirs. The reservoir water balance component is similar to the pond component except it allows flow from principal and emergency spillways. The reservoir outflow function is expressed in the equation

$$\begin{aligned} QOR &= VR - VR_F, \quad VR > VR_F \\ QOR &= (RR)(\Delta t), \quad VRsubS < VR \le VR_F \\ QOR &= 0. \quad VR < VR_s \end{aligned} \qquad (46)$$

where QOR is the daily outflow in m3, VR is the volume of water in the reservoir in m3, VRF is the reservoir capacity at the emergency spillway crest in m3, RR is the principal spillway release rate in m3·s-1, and VRS is the reservoir capacity at the principal spillway crest in m3.

For large, regulated flood control reservoirs, an approach described by the U.S. Army Corps of Engineers (U.S. Army, 1976) is used to simulate outflows. This approach tries to mimic general release rules that may be used by reservoir operators. Although the model is simplistic and cannot account for all decision criteria, it can realistically simulate major outflows and low flow periods. Additional operation rules can be added to model specific reservoirs or reservoir systems.

For this situation, the principal or normal spillway volume corresponds to maximum flood control reservation, while the emergency spillway volume corresponds to no flood control reservation. The model requires the beginning and ending month of the flood season. This varies across the U.S. but normally includes the winter months and can run into late spring in certain mountainous snowmelt areas (U.S. Army, 1976). The model uses a target storage approach based on flood season and the hydrologic condition of the watershed.

$$QO = \left(\frac{VR - VR_T}{ND_T} \right) + QR_{mo} \qquad VR > VR_T \qquad (47)$$

$$QO = QRsubmo \qquad VR < VR_T \qquad (48)$$

where VRT is the target storage in m3, NDT are the number of days to return to the target storage, and QR is the daily minimum reservoir release for month mo in m3.

In the non-flood season, no flood control reservation is required, and the target storage is set at the emergency spillway volume. During the flood season, the flood control reservation (target storage) is a function of soil water content in the watershed. The flood control reservation for wet ground conditions (field capacity) is set at the maximum and for dry ground conditions (wilting point) the flood control reservation is set at one-half the maximum.

$$VR_T = VR_S + 0.5\,(1 - SWF)\,VR_S - VR_P \qquad (49)$$

where SWF is the soil water factor and is defined with the equation

$$SWF = \frac{SW_w}{fcw} \qquad (50)$$

where SWw is the soil water content in mm, and fcw is the field capacity of the watershed drainage area in mm.

4) Urban Nonpoint Sources Inventory

4a) No Routing Component
Not available

4b) Routing Component
Not available

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Biochemical Oxygen Demand (BOD)

1) General Information
BOD, 5-day (20 day C) is one of the 15 pollutants for which monthly, seasonal and annual estimates in pounds are obtained only from point sources. BOD values can be aggregated to a spatial unit (i.e. subbasin, USGS Cataloging Unit, watershed, county, etc) of interest.

BOD is the quantity of dissolved oxygen used in the biochemical oxidation of organic matter in a specific time, at a specified time, at a specified temperature, and under specified conditions. BOD provides a somewhat standard measure of how much oxygen will be required to degrade a waste, and therefore it can be used to predict the effect waste may have on fish or other aquatic organisms that require oxygen to live.

2) Point Sources Inventory
BOD values are based on monitoring (storet parameter: 00310), permit or typical pollutant concentration (TPC) data.

3) Non-Urban Nonpoint Sources Inventory
BOD estimates are unavailable.

4) Urban Nonpoint Sources Inventory
BOD estimates are not available.

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Total Suspended Solids (TSS)

1) General Information
TSS is one of the 15 pollutants for which monthly, seasonal and annual estimates in pounds are obtained from point and nonpoint sources.

TSS represents the total amount of solid matter in a representative water sample that is retained on a membrane filter. It includes all sediment and other consituents that are fluid suspended.

2) Point Sources Inventory
TSS values are based on monitoring (storet parameter: 00530), permit or typical pollutant concentration (TPC) data.

3) Non-Urban Nonpoint Sources Inventory:

3a) No Routing Component
TSS is sediment yield (Y) obtained by the SWAT model for each virtual basin (landuse). Sediment yield is computed for each subbasin with the Modified Universal Soil Loss Equation (MUSLE) (Williams and Berndt, 1977).

$$Y = 11.8\,(V\,q_p)^{0.56}\,(K)(C)(PE)(LS) \qquad (1)$$

where Y is the sediment yield from the subbasin in t, V is the surface runoff column for the subbasin in m3, qp is the peak flow rate for the subbasin in m3·s-1, K is the soil erodibility factor, C is the crop management factor, PE is the erosion control practice factor, and LS is the slope length and steepness factor.

The LS factor is computed with the equation (Wischmeier and Smith, 1978).

$$LS = \left(\frac{\lambda}{22.1}\right)^{\xi}(65.41\,S^2 + 4.565\,S + .065) \qquad (2)$$

The exponent ξ varies with slope and is computed in SWRRB with the equation

$$\xi = 0.6\,[1 - \exp(-35.835\,S)] \qquad (3)$$

The crop management factor, C, is evaluated for all days when runoff occurs using the equation,

$$C = \exp[(-0.2231 - CVM)\exp(-0.00115\,CV) + CVM] \qquad (4)$$

where CV is the soil cover (above ground biomass+residue) in kg·ha-1 and CVM is the minimum value of C. The value of CVM is estimated from the average annual C factor using the equation

$$CVM = 1.463 \ln (CVA) + 0.1034 \qquad (5)$$

The value of CVA for each crop is determined from tables prepared by Wischmeier and Smith (1978). Values of K are contained in the SCS Soils 5 database, and PE factors can be estimated for each subbasin using information contained in Wischmeier and Smith (1978).

3b) Routing Component

The sediment routing model consists of two components operating simultaneously (deposition and degradation). The amount of sediment reaching the basin outlet, SEDout, is:

$$SED_{out} = SED_{in} - DEP + DEG \qquad (6)$$

where SEDin is the sediment entering the reach.

Deposition (DEP) is calculated with the equation:

$$DEP = SED_{in} (1 - DR) \qquad (7)$$

The sediment delivery ratio (DR) through the reach is estimated with the equations:

$$DR = \frac{1 - 0.5\, y_f}{d_q} \qquad y_f > d_q \qquad (8)$$

$$DR = \frac{0.5 (d_q)}{y_f} \qquad y_f > d_q \qquad (9)$$

where dq is the depth of flow.

The depth (y f) that sediment of particle size d will fall during time, TT, is

$$y_f = (V_f)(TT) \qquad (10)$$

Deposition in the stream channel is based on the fall velocity of the sediment particles (Arnold et al., 1990). With a temperature of 22°C and a sediment density of 1.2 t·m-3, Stokes' Law for fall velocity becomes:

$$V_f = 411 (d^2) \qquad (11)$$

where Vf is the fall velocity in m·h-1 and d is the sediment particle diameter.

Degradation (DEG), which is the sum of the reentrainment and bed degradation components and which is also allowed to be redeposited before reaching the basin outlet is computed by:

$$DEG = (DEG_R + DEG_B)(1 - DR) \qquad (12)$$

Stream power is used to predict degradation in the routing reaches. Williams (1980) used Bagnold's (1977) definition of stream power to develop a method for determining degradation in channels. Bagnold defined stream power, SP, with the equation:

$$SP = \gamma q S_w \qquad (13)$$

where \ is the density of the water, q is the flow rate, and SW is the water surface slope. By applying stream power to bed load predictions (Bagnold, 1977) and estimating model parameters (Williams, 1980), the equation for sediment reentrained, DEGR, is

$$DEG_R = \alpha_{sp} \gamma^{1.5} (dur) (w) (d_1 S_w V_c)^{1.5} \qquad (14)$$

where ÿsp is a parameter dependent on maximum stream power for the reach and Vc is the velocity in the channel.

The parameter ÿsp can be estimated with the equation:

$$\alpha_{sp} = (\gamma_w q S_c)_{mx}^{-0.5} \qquad (15)$$

where Sc is the slope of the channel and the subscript mx refers to the maximum flow expected in the reach for extreme events. The value of q is assumed to equal some maximum rainfall intensity (250 mm/hr) and α_{sp} becomes:

$$\alpha_{sp} = (69.44 \gamma DA S_c)^{-0.5} \qquad (16)$$

where DA is the drainage area into the reach in km2.

All of the stream power is used for reentrainment of loose and deposited material until all of the material has been removed. When this occurs, degradation of the bed material, DEGB, begins and is calculated by:

$$DEG_B = K C DEG_R \qquad (17)$$

where K and C are MUSLE (Williams and Berndt, 1977) factors for the stream channel.

Impoundment Sediment Routing

The sediment balance equation for reservoirs is:

$$SR_i = SR_{i-1} + SR_{in} - SR_{out} - SR_{DEP} \qquad (18)$$

where SRi is the total sediment in the reservoir, SRi-1 is the total sediment in the reservoir on the previous day, SRin is the incoming sediment, SRout is the sediment transported in the sediment outflow, and SRDEP is the amount of sediment deposited in the reservoir. Sediment outflow from reservoirs is calculated with the equation

$$SR_{out} = c_o q_o \qquad q_o > 0 \qquad (19)$$

$$SR_{out} = 0 \qquad q_o = 0 \qquad (20)$$

where co is the outflow sediment concentration. The outflow concentration is a function of the reservoir concentration at the beginning and end of the day

$$c_o = \frac{cs_1 + cs_2}{2} \qquad (21)$$

where cs1 and cs2 are the reservoir sediment concentrations at the beginning and end of the day, respectively.

The initial reservoir concentration is input to the model. The inflow concentration can be calculated since qi and SRin are simulated, but the final reservoir concentration is unknown. It can be computed using the continuity equation

$$V_2 cs_2 = V_1 cs_1 + q_i c_i - q_o c_o \qquad (22)$$

where V1 and V2 are the storage volumes at the beginning and end of the day, and ci is the inflow sediment concentration. Substituting equation 21 into equation 22 and rearranging yields an expression for the final concentration

$$cs_2 = \frac{V_1 cs_1 + q_i c_i - (\frac{q_o}{2}) cs_1}{V_2 + (\frac{q_o}{2})} \qquad (23)$$

Between storms the final reservoir concentration decreases to an equilibrium concentration according to the equation

$$c_s = (cs_2 - cs_e)\exp(-k_s t d_{50}) + cs_e \qquad (24)$$

where cs is the resevoir concentration t days after the value of cs2 is obtained, ks is the decay constant, d50 is the median particle size of the inflow sediment, and cse is the equilibrium sediment concentration (input to the model). A value of ks is evaluated by assuming that 99% of the 1 µm particles are settled within 25 days (ks=0.184).

4) Urban Nonpoint Sources Inventory
TSS estimates are not available

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Total Nitrogen (TN)

1) General Information
TN is one of the 15 pollutants for which monthly, seasonal and annual estimates are obtained in pounds from point and nonpoint sources. TN values can be aggregated to a spatial unit (i.e. subbasin, USGS Cataloging Unit, watershed, county, etc) of interest.

Nitrogen (N2) is the most abundant element in the earth's atmosphere, but it is present in an unvisible form. Dimolecular nitrogen (N2) is neither soluble or reactive, two properties which are necessary before either plants or animals can use it to build proteins. The most biologically important inorganic forms of nitrogen are ammonium (NH4), nitrate (NO3), and nitrite (NO2). Organic nitrogen occurs as particulate matter, in living organisms, and as detritus. It occurs in dissolved form in compunds such as amino acids, amines, purines, and urea. The nitrogen human health and environmental effects are various depending on its form. For instance nitrate which is converted to nitrite in the stomach can lead to a condition known as methemoglobinemia, an acute toxic response to nitrite exposure. Metheglobin is the transformation product of hemoglobin, present when ferrous iron in hemoglobin is oxidized to ferric iron. It precludes the transport of oxygen by the blood, which can result in brain damage or, even, death.

2) Point Sources Inventory
TN values are based on monitoring (storet parameter: 00600), permit or typical pollutant concentration (TPC) data. Prior using permit or TPC data, if TN monitoring data are unavailable, these are computed using available monitoring data for nitrogen species [storet parameters: 00605 (organic), 00610 (ammonia (NH4)), 00615 (nitrite (NO2)), 00620 (nitrate (NO3)), 00625 (kjedhal), and 00640 (inorganic)]. The following rules are used while using nitrogen species monitoring data.

a) Obtaining loading estimates for nitrogen species (organic, NH4, and inorganic. It is assumed that inorganic is (NO3 + NO2) and that kjedhal is (NH4 + organic). Nitrogen species are computed in a way that total nitrogen will add up as follows:

TN = (NH4 + organic + NO3 + NO2);

b) If inorganic exists and NO3 and NO2 are missing, then:

NO3 = inorganic x 0.7
NO2 = inorganic x 0.3

c) If inorganic and NO3 exist but NO2 is missing then:

NO2 = inorganic - NO3

d) If this computation is negative, meaning that NO3 > inorganic then:

NO2 = 0

similar computation applies for the case where NO3 is missing and NO2 exists.

e) If inorganic and NO3 and NO2 exist then inorganic is ignored.

f) If kjedhal exists and NH4 and organic are missing then:

NH4 = kjeldahl / 2
organic = kjeldahl / 2

g) If kjeldahl and NH4 exists and organic is missing then:

organic = kjedhal - NH4

h) If this computation is negative, meaning that NH4 > kjedhal then:

organic = 0

similar computaion applies for the case that NH4 is missing and organic exists.

i) If kjedhal, NH4 and organic exist then kjedhal is ignored.

j) If TN is not missing and it is not zero and if nitrogen species data are missing, nitrogen species coefficients were obtained for Industries and Waste Water Treatment Plants (WWTPs) to compute nitrogen species loads.

For Industries the coefficients are equally distributed for all species (ammonia, inorganic and organic) , that is:

NH4 (0.34), N03 (0.165), NO2 (0.165), and organic (0.33)

For WWTPs the coefficients are distributed accordingly to what typically the ratio NH4 / TN is for different treatment processes based on information derived from the book entitled
"Managing Wastewater in Coastal Urban Areas" by The National
Research Council. The coefficients are:

For Untreated:
NH4 (0.47), N03 (0.14), NO2 (0.13), and organic (0.26)

For Primary:
NH4 (0.34), N03 (0.165), NO2 (0.165), and organic (0.33)

For Advanced Primary:
NH4 (0.34), N03 (0.165), NO2 (0.165), and organic (0.33)

For Secondary:
NH4 (0.17), N03 (0.21), NO2 (0.21), and organic (0.41)

For Advanced Secondary:
NH4 (0.25), N03 (0.19), NO2 (0.19), and organic (0.37)

For Tertiary:
NH4 (0.20), N03 (0.20), NO2 (0.20), and organic (0.40)

Note: Values for Primary and Advanced Primary are not available in the National Research Council book, therefore, values are obtained by distributing them equally among ammonia, inorganic and organic.

k) If TN is not missing and it is not zero and if a monitoring value exists for a nitrogen specie (eg. NH4) then this value is used and values for the other species are derived as follows:

TN = ammonia + inorganic + organic

where:

inorganic = (TN - ammonia) 0.5
organic = (TN - ammonia) 0.5

l) If TN value is zero or missing and one or more species data exist, total nitrogen is obtained by summing all species data.

m) If TN exists and sum of species is greater than TN then the value of TN was replaced by the sum of the species data.

3) Non-Urban Nonpoint Sources Inventory:

3a) No Routing Component
TN is estimated by the SWAT model for each virtual basin (landuse) (subbasin file) by:

TN = Nitrate in Surface Runoff + Nitrate in Sub-Surface Runoff + Organic-N in Sediment

Nitrate in Surface Runoff. The amount of NO3-N in runoff is estimated for each subbasin for considering the top soil layer (10 mm thickness) only. The total amount of water leaving the layer is the sum of runoff, lateral subsurface flow, and percolation.

$$QT = Q + O_1 + QR_1 \qquad (1)$$

where QT is the total water lost from the first layer in mm, Q is the runoff volume in mm, O1 is the percolation from the first layer in mm, and QR1 is the lateral flow from the first layer in mm. The amount of NO3-N lost with QT is

$$VNO3 = (QT)(C_{NO3}) \qquad (2)$$

where VNO3 is the amount NO3-N lost from the first layer and CNO3 is the concentration of NO3-N in the first layer. At the end of the day, the amount of NO3-N left in the layer is

$$WNO3 = WNO3_o - (QT)(C_{NO3}) \qquad (3)$$

where WNO3O and WNO3 are the weights of NO3-N contained in the layer at the beginning and ending of the day. The NO3-N concentration can be estimated by dividing the weight of NO3-N by the water storage volume:

$$C'_{NO3} = C_{NO3} - C_{NO3}\left(\frac{-QT}{PO_1 - WP_1}\right) \qquad (4)$$

where C'NO3 is the concentration of NO3-N at the end of the day, PO is the soil porosity, and WP is the wilting point water content for soil layer one in mm. Equation 4 is a finite different appoximation for the exponential equation $$C'_{NO3} = C_{NO3} - \exp\left(\frac{-QT}{PO_1 - WPsub1}\right) \qquad (5)$$

thus, VNO3 can be computed for any QT value by integrating equation 5.

$$VNO3 = WNO3\left(1 - \exp\left(\frac{-QT}{PO_1 - WP_1)}\right)\right) \qquad (6)$$

The average concentration of QT for the day is

$$C_{NO3} = \frac{VNO3}{QT} \qquad (7)$$

Amounts of NO3-N contained in runoff, lateral flow, and percolation are estimated as the products of the volume of water and the concentration from equation 7.

Nitrate in sub-surface runoff in lower layers is treated with the same approach used in the upper layer except surface runoff is not considered.

Organic N in Sediment. A loading function developed by McElroy et al. (1976) are modified by

Williams and Hann (1978) for application to individual runoff events is used to estimate organic N loss for each subbasin. The loading function

$$YON = 0.001\,(Y)\,(CON)\,(ER) \qquad (8)$$

where YON is the organic N runoff loss at the subbasin outlet in kg·ha-1, CON is the concentration of organic N in the top soil layer in g·t-1, Y is the sediment yield in t·ha-1, and ER is the enrichment ratio. The value of CON is input to the model and is constant throughout the simulation. The enrichment ratio is the concentration of organic N in the sediment divided by that of the soil. Enrichment ratios are logarithmically related to sediment concentration as described by Menzel (1980). An individual event enrichment sediment concentration relationship was developed for SWAT considering upper and lower bounds. The upper bound of enrichment ratio is the inverse of the sediment delivery ratio. Exceeding the inverse of the delivery ratio implied that more organic N leaves the watershed than is dislodged from the soil. The delivery ratio is estimated for each runoff event using the equation

$$DR = \left(\frac{q_p}{r_{ep}}\right)^{0.56} \qquad (9)$$

where DR is the sediment delivery ratio (subbasin sediment yield divided by gross sheet erosion), qp is the peak runoff rate in mm·h-1, and rep is the peak rainfall excess rate in mm·h-1. Equation 141 is based on sediment yield estimated using MUSLE (Williams, 1975). The rainfall excess rate cannont be evaluated directly because the hydrology model only predicts the total daily runoff volume. An estimate of the rate can be obtained, however, using the equation

$$r_{ep} = r_p - f \qquad (10)$$

where rp is the peak rainfall rate in mm·h-1 and and *f* is the average infiltration rate in mm·h-1. The average infiltration rate can be computed from the equation

$$f = \frac{R - Q}{DUR} \qquad (11)$$

where DUR is the rainfall duration in h and R is rainfall in mm. The procedure for estimating the rainfall duration is given in Williams et al. (1984).

$$DUR = \frac{4.605\,R}{r_p} \qquad (12)$$

The lower limit of enrichment ratio is 1.0-sediment particle size distribution is the same as that of the soil. thus, $1<ER<1/DR$. The logarithmic equation estimating enrichment ratio is

$$ER = x_1 c_a^{x_2} \qquad (13)$$

where ca is the sediment concentration in g·m-3 and x1 and x2 are parameters set by the upper and lower limits. To approach an enrichment ratio is 1.0, the sediment concentration would be extremely high. Conversely, a very low sediment concentration would cause the enrichment ratio to approach 1/DR. The simultaneous solution of equation 13 at the boundaries assuming sediment concentrations range from 500 to 250,000 g·m-3 gives

$$x_2 = \frac{\log\left(\frac{1}{DR}\right)}{2.699} \qquad (14)$$

$$x_1 = 1 / (0.25)^{x_2} \qquad (15)$$

3ai) Important Nitrogen Processes

a) Denitrification:

As one of the microbial processes, denitrification is a function of temperature and water content. The equation used to estimate the denitrification rate is

$$DN_l = WNO3_l\left(1 - \exp[-1.4(TF_{Nl})(C_l)]\right), \quad SWF \geq 0.95 \qquad (16)$$
$$DN = 0., \qquad SWF < 0.95$$

DN is the denitrification rate in l layer in kg·ha-1·d-1, TFn is the nutrient cycling temperature factor, C is the organic carbon content in %, and SWF is the soil water factor. The temperature factor is expressed by the equation

$$TF_{Nl} = \max\begin{cases} 0.1 \\ \dfrac{T_l}{T_l + \exp(9.93 - 0.312T_l)} \end{cases} \qquad (17)$$

where T is soil temperature in °C and subscript l refers to the layers. The soil water factor considers total soil water in the equation

$$SWF_l = \frac{SW_l}{FC_l} \qquad (18)$$

where SW is the soil water content in layer l and FC is the field capacity in mm.

b) Mineralization:
The N mineralization model is a modification of the PAPRAN mineralization model (Seligman and van Keulen, 1981). The model considers two sources of mineralization: fresh organic N pool, associated with crop residue and microbial biomass, and the stable organic N pool, associated with the soil humus. Mineralization from the fresh organic N pool is estimated with the equation

$$RMN_l = (DCR_l)(FON_l) \qquad (19)$$

where RMN is the N mineralization rate in kg·ha-1·d-1 for fresh organic N in layer l , DCR is the decay rate constant for the fresh organic N, and FON is the amount of fresh organic N present in kg·ha-1. The decay rate constant is a function of C:N ratio, C:P ratio, composition of crop residue, temperature, and soil water:

$$DCR_l = 0.05(CNP_l)\sqrt{\left(\frac{SW_l}{FC_l}\right) \cdot TF_{N,l}} \qquad (20)$$

where CNP is a C:N and C:P ratio factor and FC is the soil water content in mm at field capacity. The value of CNP is calculated with the equation

$$CNP_l = \min \begin{cases} \exp\left[\frac{-0.693(CNR - 25)}{25}\right] \\ \exp\left[\frac{-0.693(CPR_l - 200)}{200}\right] \\ 1.0 \end{cases} \qquad (21)$$

where CNR is the C:N ratio and CPR is the C:P ratio in layer l . The C:N and C:P ratios of crop residue are computed for each soil layer with the equations

$$CNR_l = \frac{0.58FR_l}{FON_l + WNO3_l} \qquad (22)$$

$$CPR_l = \frac{0.58 FR_l}{FOP_l + AP_l} \qquad (23)$$

where FON is the amount of fresh organic N in kg·ha-1 , FOP is the amount of fresh organic P in kg·ha-1, and AP is the amount of labile P in kg·ha-1 for layer l .

Organic N associated with humus is divided into two pools--active and stable--by using the equation

$$ON_{a,l} = (RTN_l)(ON_l) \qquad (24)$$

where ONa is the active or readily mineralizable pool in kg·ha-1, RTN is the active pool fraction (set at 0.15), ON is the total organic N in kg·ha-1, and the subscript l is the soil layer number. Organic N flux between the active and stable pools is goverened by the equilibrium equation

$$RON_l = BKN \left(ON_{a,l} \left(\frac{1}{RTN_l} \right) - ON_{s,l} \right) \qquad (25)$$

where RON is the flow rate in kg·ha-1·d-1 between the active and stable organic N pools, BKN is the rate constant (=1 X 10-5·d-1), ONs is the stable organic N pool, and subscript is the soil layer number. The daily flow of humus related organic N (RON) is added to the stable pool and subtracted from the active pool.

Only the active pool of organic N is subjected to mineralization. The humus mineralization equation is

$$HMN_l = (CMN)(ON_{a,l})(SWF_l \cdot TF_{N,l})^{0.5} \qquad (26)$$

where HMN is the mineralization rate in kg·ha-1·d-1 for the active organic N pool in layer and CMN is the humus rate constant (=0.0003 d-1). To maintain the N balance at the end of the day, the humus mineralization is subtracted from the active organic N pool; the residue mineralization is subtracted from the FON pool; 20% of RMN is added to the active ON pool; and 80% of RMN is added to WNO3 pool.

c) Immobilization:

The daily amount of immobilization is computed by subtracting the amount of N contained in the crop residue from the amount assimilated by the microorganisms:

$$WIM_l = (DCR_l)(FR_l)(0.016 - c_{NFR}) \qquad (27)$$

where WIM is the N immobilization rate in layer l in kg·ha-1·d-1; 0.016 is the result of assuming that C=0.4 FR, that C:N of the microbial biomass and their labile products = 10, and that 0.4 of C in the residue is assimilated; and cNFR is the N concentration in the crop residue in g·g-1. Immobilization may be limited by N or P availability. If the amount of N available is less than the amount of immobilization predicted from equation 27, the decay rate constant is adjusted with the relationship

$$DCR'_{\ell} = \frac{0.95\ WNO3_{\ell}}{FR_{\ell}\,(0.016 - c_{NFR})} \qquad (28)$$

where DCR' allows 95% use of the available NO3-N in soil layer . A similar adjustment is made if P is limiting. The crop residue is reduced by using the equation

$$FR_{\ell} = FR_{o\ell} - (DCR'_{\ell})\,(FR_{o\ell}) \qquad (29)$$

where FRo and FR are the amounts of residue in soil layer at the start and end of a day in kg·ha-1. Finally, the immobilized N is added to the FON pool and subtracted from the WNO3 pool.

d) Rainfall:

To estimate the N contribution from rainfall, SWAT uses an average rainfall N concentration of 8 ppm for all locations for all storms. The amount of N in rainfall is estimated as the product of rainfall amount and concentration. This concentration corresponds to 6 lb/acre for 30 inches of rainfall.

e) Crop Uptake:

Crop use of N is estimated using a supply and demand approach. The daily (day i) crop N demand can be computed using the equation

$$UND_{i} = (C_{NB})_{i}\,B_{i} - (C_{NB})_{i-1}\,B_{i-1} \qquad (30)$$

where UNDi is the N demand of the crop in kg·ha-1, CNB is the optimal N concentration of the crop, and B is the accumulated in kg·ha-1. The optimal crop N concentration is computed as a function of growth stage using the equation

$$C_{NB} = 4.0\,(bn) + 1.54\,(bn)\exp(-bn\,B_{1}) \qquad (31)$$

where bn is a crop parameter expressing N concentration and B1 is the fraction of the growing season. The value of B1 is estimated as a function of heat units

$$B_{1,i} = \sum_{k=1}^{i} \frac{HU}{PHU} \qquad (32)$$

where HU is the daily heat units in °C above the crop's base temperature and PHU is the potential heat units to mature the crop in °C.

The crop is allowed to take N from any soil layer that has roots. Uptake starts at the upper layer and proceeds downward until the daily demand is met or until all N has been depleted. If the soil cannont supply the daily N demand for legumes, the deficit is attributed to N fixation.

3b) Routing Component

TN is estimated by the SWAT model at the subbasin outlet in the routing component (reach file) by:

TN = Nitrate (NO3-N) + Nitrite (NO2-N) + Organic-N + Ammonium (NH4-N)

Nitrate/Nitrite Routing**-** Once NO3-N enters a stream it is considered a conservative material for the duration of an individual runoff event (Williams, 1980). Thus, NO3-N routing is simply a matter of adding the yields from all subbasins to determine the basin yield.

Organic-N Routing- The loading function approach is also used in routing organic N from the subbasin outlets to the basin outlet.

$$YON_{Bj} = 0.01\,(Y_B)_j\,(CONSB)_j\,(ER_R)_j \qquad (33)$$

where YONB is the organic N runoff loss at the basin outlet in kg·ha-1, YB is the sediment yield reaching the basin outlet from subbasin j in t·ha-1, CONSB is the concentration of organic N in the sediment reaching the subbasin j outlet in g·t-1, and ERR is the enrichment ratio for the channel routing from subbasin j to the channel outlet. The estimate of ERR is calculated by equations 13, 14, and 15 with the delivery ratio for the channel routing calculated from

$$DR = \frac{(Y_{SB})_j}{(Y_B)_j} \qquad (34)$$

where YSB is the sediment yield at the subbasin outlet in t·ha-1, and YB is that sediment yield from subbasin j after it has been routing to the basin oulet in t·ha-1. Arnold et al. (1991) describe the sediment routing procedure in detail.

4) Urban Nonpoint Sources Inventory:

Not available

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Total Phosphorus (TP)

1) General Information
TP is one of the 15 pollutants for which monthly, seasonal and annual estimates are obtained from point and nonpoint sources. TP values can then be aggregated to a spatial unit (i.e. subbasin, USGS Cataloging Unit, watershed, county, etc) of interest.

Phosphorus is a nonmetallic element, a white phosphorescent, waxy solid, that becomes yellow when exposed to light. It is required by plants and animals for maintaining their growth and metabolism. Phosphorus is taken in by plants as inorganic phosphate and converted to a great variety of organic phosphate compounds. Animals get phosphorus as inorganic phosphates in the water they drink, or as inorganic plus organic phosphate in the food they eat (Tver, 1982).

Phosphorus is naturally found in aquatic environments. The normal level for phosphorus in aquatic environments should be less than 0.05 mg/l . However, when the amount of phosphorus exceeds this level, aquatic productivity can increase dramatically. This process, known as eutrophication, can adversely affect the aquatic environment (EPA, 1993). In addition to eutrophication, negative impacts such as nuisance algal blooms and dieback of coral and seagrasses also occur when there are excessive levels of phosphorus (NRC, 1993).

There are many sources of phosphorus found in the environment. The primary sources of phosphorus include agricultural runoff, decaying plants and animals, and animal wastes (Andrews, 1972). Phosphorus can be found in sewage, industrial effluents and detergents as well. The environmental effects that come from excessive levels of phosphorus also have been well documented. When algal blooms occur, the dense, slimy layer reduces light penetration and restricts reoxygenation of the water. This can cause very adverse conditions for swimming, fishing, and river navigation (Dix, 1981). Depleted oxygen levels restrict the quality of fish habitat and highly enriched waters stimulate algal production, which increases turbidity and therefore causes less availability of sunlight to submerged aquatic vegetation(SAV). This can have severe effects on the food chain, since the SAV is a home for many fish (EPA, 1993).

2) Point Sources Inventory
TP values are based on monitoring (storet parameter: 00665), permit or typical pollutant concentration (TPC) data.

3) Non-Urban Nonpoint Sources Inventory:

3a) No Routing Component
TP is calculated by:

TP = soluble phosphorus in surface runoff + phosphorus transport by sediment

Soluble Phosphorus in Surface Runoff. The SWAT approach is based on the concept of partitioning pesticides into the solution and sediment phases as described by Leonard and Wauchope (Knisel, 1980). Because P is mostly associated with the sediment phase, the soluble P runoff equation can be expressed in the simple form

$$YSP = \frac{0.01\,(C_{LPP})\,(Q)}{k_d} \qquad (1)$$

where YSP is the soluble P in kg·ha-1 lost in runoff volume Q in mm, CLPP is the concentration of AP in soil layer P in g·t-1, and kd is the P concentration in the sediment divided by that of the water in m3·t-1. The value of CLP is input to the model and remains constant. The value of kd used in SWAT is 175.

Phosphorus Transport by Sediment. Sediment transport of P is simulated with a loading function as described in organic N transport. The P loading function is

$$YP = 0.01\,(Y)\,(C_p)\,(ER) \qquad (2)$$

where YP is the sediment phase of P loss in runoff in kg·ha-1 and cp is the concentration of P in the top soil layer in g·t-1.

3b) Routing Component
As with NO3-N routing, once soluble P enters a stream it is considered a conservative material and routing is accomplished by adding the yields from all subbasins to determine the basin yield.
Again, the loading function approach is used in routing P from the subbasin outlets to the basin outlet.

$$YP_{Bj} = 0.01\,(Y_B)_j\,(C_{PSB})_j\,(ER_B)_j \qquad (3)$$

where YPB is the P yield at the basin outlet in kg·ha-1, and CPSB is the P concentration in the sediment reaching the subbasin j outlet in g·t-1.

The lower limit of enrichment ratio is 1.0-sediment particle size distribution is the same as that of the soil. thus, 1¾ER¾1/DR. The logarithmic equation estimating enrichment ratio is

$$ER = x_1\, c_a^{x_2} \qquad (4)$$

where ca is the sediment concentration in g·m-3 and x1 and x2 are parameters set by the upper and lower limits. To approach an enrichment ratio is 1.0, the sediment concentration would be extremely high. Conversely, a very low sediment concentration would cause the enrichment ratio to approach 1/DR. The simultaneous solution of equation 4 at the boundaries assuming sediment concentrations range from 500 to 250,000 g·m-3 gives

$$x_2 = \frac{\log\left(\frac{1}{DR}\right)}{2.699} \qquad (5)$$

$$x_1 = 1 / (0.25)^{x_2} \qquad (6)$$

$$DR = \frac{(Y_{SB})_j}{(Y_B)_j} \qquad (7)$$

where YSB is the sediment yield at the subbasin outlet in t·ha-1, and YB is that sediment yield from subbasin j after it has been routing to the basin oulet in t·ha-1. Arnold et al. (1991) describe the sediment routing procedure in detail.

4) Urban Nonpoint Sources Inventory
Not available.

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Total Arsenic (As)

1) General Information
Arsenic is one of the 15 pollutants for which monthly, seasonal and annual estimates are obtained from only point sources. Arsenic values can then be aggregated to a spatial unit (i.e. subbasin, USGS Cataloging Unit, watershed, county, etc) of interest.

Elemental arsenic (As) is a gray, crystalline material not known to be essential to humans. Arsenic in nature is more commonly found in arsenic compounds and rarely in its elemental state (Eisler, 1988). Arsenic compounds have been used in medicine since the time of Hippocrates, ca. 400 BC (Woolson ,1975). Inorganic arsenicals have been used for centuries, and organoarsenicals for at least a century in the treatment of syphylis, yaws, amoebic dysentery, and trypanosomiasis (NAS, 1977). During the middle ages (1200 to 1650), however, arsenic was used extensively in homicides (NRCC, 1978). In 1815, the first accidental death was reported from arsine (AsH_3) poisoning, and in 1900-1903 accidental poisonings from consumption of arsenic-contaminated beer were widely reported (NRCC, 1978). In 1938, it was established that arsenic can counteract selenium toxicity (NRCC, 1978). The introduction of arsphenamine, an organoarsenical, to control venereal disease earlier this century gave rise to intensive research by organic chemists, which resulted in the synthesis of at least 32,000 arsenic compounds. However, the advent of penicillin and other drugs nearly eliminated the use of organic arsenicals as human therapeutic agents (EPA, 1980).

Global production of arsenic is estimated to be 75,000 to 100,000 tons annually, of which the United States produces about 21,000 tons and uses about 44,000 tons; major quantities are imported from Sweden, the world's leading producer (NAS, 1977; EPA, 1980). Almost all (97%) of the arsenic made worldwide enters end-product manufacture in the form of arsenic trioxide (As_2O_3), and the rest is used as additives in producing special lead and copper alloys (NAS, 1977). More than 80% of the As_2O_3 is used to manufacture products with agricultural application, such as insecticides, herbicides, fungicides, algicides, sheep dips, wood preservatives, dyestuffs, and the medicines for eradication of tapeworm in sheep and cattle (NAS, 1977).

Agricultural applications provide the largest anthropogenic source of arsenic in the environment (Woolson, 1975). Inorganic arsenicals (arsenic trioxide; arsenic acid; arsenates of calcium, copper, lead, and sodium; and arsenites of sodium and potassium) have been used widely for centuries as insecticides, herbicides, algicides, and dessicants. Arsenic is also released into the environment as a result of smelting or roasting sulphide minerals, the combustion of fossil fuels, leaching of exposed wastes from mining activity, and accelerated erosion of land. Volcanoes, the burning of vegetation and continental weathering are major natural contributors of arsenic to the environment (GESAMP, 1986).

Various human health and environmental effects are caused by arsenic. Exposure of humans and wildlife to arsenic may occur through air (emissions from smelters, coal-fired power plants, herbicide sprays), water (mine tailings runoff, smelter wastes, natural mineralization), and food (especially seafood) (EPA, 1985). Arsenic intake via air is mainly in inorganic forms and less than 0.1 g of As is "taken in " daily in urban areas, but can occasionally, near point emissions, reach 20 g As/day. Arsenic in drinking water is in inorganic forms and normally contributes less than 10 g As/day. However, in areas with arsenic-containing groundwater the contribution can reach several mg As/day (GESAMP, 1986). The EPA limit for arsenic in drinking water is 0.05 mg/L (Hodges, 1973). Most food products, with the exception of seafood, contain less than 0.25 mg As per kg of food. The FDA limit on arsenic in food is 2.6 mg As per kg of food (Hodges, 1973). Seafood commonly contains arsenic in the order of milligrams per kg. However, most of it (90%) is in organic form, mainly arsenobetaine, which is far less toxic than inorganic arsenic. In general, the highest concentrations of arsenic are found in bottom-feeding fish and crustacea. It can be calculated that the average daily intake of organic arsenic from seafood is 20-200 g As with one meal per week, but may reach 10,000 g As in case of extreme seafood consumption, such as 1 kg of flatfish, crustacea or mollusks per day. The daily intake of inorganic arsenic from seafood may reach less than 10 g As to more than 500 g As in case of very extreme seafood consumption (GESAMP, 1986).

Inorganic arsenicals are more toxic than organic arsenicals and trivalent forms are more toxic than pentavalent forms. Arsenicals are readily absorbed after ingestion, most being rapidly excreted in the urine during the first few days, or at most a week (the effects seen after long-term exposure are probably a result of continuous daily exposure, rather than of accumulation) . While arsenic does bioaccumulate in organisms, it is not biomagnified in the food chain (Eisler, 1988). Arsenic is in the same group of the periodic table as phosphorus and can substitute for phosphorus in certain biochemical reactions with devastating effects, especially since the most common energy source in intermediary metabolic reactions is the P-O-P chemical bond of ATP (adenosine triphosphate) (Hodges, 1973).

2) Point Sources Inventory
Arsenic values are based on monitoring (storet parameter: 01002), permit or typical pollutant concentration (TPC) data.

3) Nonpoint Sources Inventory
Arsenic estimates not available.

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Total Cadmium (Cd)

1) General Information

Cadmium is one of the 15 pollutants for which monthly, seasonal and annual estimates are obtained from only point sources. Cadmium values can then be aggregated to a spatial unit (i.e. subbasin, USGS Cataloging Unit, watershed, county, etc) of interest.

Cadmium (Cd) is a soft, silvery-white metal that has many uses. It is currently used primarily for the production of nickel-cadmium batteries (35%) and for metal plating (30%). It is also used for pigments (15%), in plastics as a stabilizer (10%), and for alloys and other miscellaneous uses (10%) (U.S. Dept. of Health and Human Services, 1991). Cadmium is one of several "trace metals" existing in nature in small quantities that have no known nutritive value and are capable of producing a toxic effect. The toxic action of cadmium seems to involve the replacement of zinc in certain enzymes by cadmium, which prevents proper functioning of the enzymes (Hodges, 1973).

There are many sources of cadmium in the environment. It is released into the air from smelters (of zinc, lead, and copper); from the burning of plastics, pigments, Ni-Cd batteries, motor oil, rubber goods and tires, and other cadmium-containing items. Cadmium can enter waterways from industrial waste waters (especially metal alloy and electroplating industries) and by dissolution from galvanized iron objects whose zinc coating contains cadmium. Cadmium is also widely distributed in the earth's crust at an average concentration of about 0.1 mg/kg. Volcanic activity represents an additional natural source of cadmium release to the atmosphere (IPCS).

The most serious cases of environmental pollution by cadmium occurred in Japan after World War II. In 1946 Dr. Noboru Hagino noted a syndrome ("itai-itai" or "ouch-ouch" disease) that occurred in Toyama Prefecture that began with renal dysfunction and eventually resulted in painful bone changes. The source of the problem was ultimately identified as cadmium in the wastes of the Kamioka mine of the Mitsui Mining and Smelting Company. The cadmium was transported to rice paddies irrigated from the Jintsu River. The daily cadmium intake in the endemic area was approximately 600 ug (Ui, 1972).

Various human health and environmental effects are caused by cadmium. Food and cigarette smoke are the largest potential sources of cadmium exposure for members of the general population. Average cadmium levels in U.S. foods range from 0.002 - 0.04 ug/g. Average cadmium levels in cigarettes range from 1 - 2 ug/cigarette. Air levels in U.S. cities range from 5 to 40 nanograms per cubic meter (ng/m3). The level of cadmium in most drinking water supplies is less than 1 ug/L (note: The EPA's limit on cadmium in drinking water is 10 ug/L). In the United States, the average person eats food with about 30 micrograms (ug) of cadmium in it each day. About 1 - 3 ug per day of cadmium is absorbed from food, and smokers absorb an additional 1 - 3 ug per day from cigarettes (0.1 - 0.2 ug of Cd are absorbed per cigarette). Smoke from other people's cigarettes probably does not cause nonsmokers to take in much cadmium. Cadmium is found at hazardous waste sites at average concentrations of about 4 ppb in soil and 5 ppb in water. Workers can be exposed to cadmium in air during the manufacture of cadmium-containing products such as batteries or paints. Workers can also be exposed from working with metal by soldering or welding. Each year almost 90,000 workers are exposed to cadmium in the United States (U. S. Dept. of Health and Human Services, 1991).

Cadmium accumulates in the body, the concentration increasing with age. Adults (aged about 50 years) have from 10 mg to 50 - 60 mg, the lowest values occurring in Africa and the highest in Japan; in the United States the adult average is about 30 mg. A newborn infant has only about 1 ug in the body. Workers who died from cadmium poisoning were found to have 100 - 1200 mg Cd in their bodies, but the body burdens may have been higher at the time the exposure ceased (Hodges, 1973).

2) Point Sources Inventory
Cadmium values are based on monitoring (storet parameter: 01027), permit or typical pollutant concentration (TPC) data.

3) Nonpoint Sources Inventory
Cadmium estimates are not available.

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Gulf of Mexico Land-Based Pollution Sources Inventory

Point Sources of Pollution

Point Source Inventory
The inventory includes background data and pollutant discharge estimates for 766 major and 8,147 minor direct point sources discharging in the watersheds and coastal drainage areas of the Gulf of Mexico.

The point source inventory consists of seven data files. Most users will find File 7 to be the most useful, because it contains information describing the facility (e.g. name, location, receiving water, major/minor facility designation, and type of industrial activity or level of wastewater treatment) and seasonal and annual estimates of discharges for each of the 8,913 facilities in the Inventory for the 15 pollutant parameters. In addition, all seven files also can be linked in a relational database framework through the common variable containing the facility permit number (NPID).

The pollutant loading estimates in the Inventory are based on a hierarchy of data sources. For point sources in the U.S. portions of the study area, the highest priority source is derived from data from the EPA's National Pollutant Discharge Elimination System (NPDES) program as reported in each facility's discharge monitoring report. When this information was not available, permitted discharge limits set for the facility are used. If neither monitoring or permit pollutant data were available, engineering values [typical pollutant concentrations (TPC) and typical flows] associated with the facility's industrial activity or level of wastewater treatment are used for the estimate (2).

The Point Source Loading Estimation Program (PSLEP),written in the Statistical Analysis System (SAS), uses several simple algorithms to generate the discharge estimates and maintains an audit trail of basis and source codes to provide the user with a means to evaluate the relative confidence that can be placed in the estimate. It also contains a set of statistically-based decision rules designed to screen out unreliable monitored data.

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Gulf of Mexico Land-Based Pollution Sources Inventory

Point Sources of Pollution

Results of the 1991 Point Source Inventory

A variety of results can be drawn from the analysis of the point source inventory. Some of the major findings are presented below:

- **Distribution of Facilities in Study Area**
  There are 766 major and 8,147 minor facilities in the study area. There are 6,909 active industrial facilities, 1,925 wastewater treatment plants, and 79 power plants. Thirty six percent of the facilities (3,235 out of 8,913) in the study area are located in two watersheds, Atchafalaya/Vermilion Bays and Galveston Bay. No other single watershed in the Gulf of Mexico accounts for more than nine percent of the facilities in the region.

- **Important Discharge Activities for all Pollutants**
  The types of discharge activities that account for the greatest proportion of loads in the study area are wastewater treatment plants and pulp and paper mills.

  1. The City of New Orleans waste water treatment plant located in New Orleans, in the Mississippi River watershed, is the largest discharger of process flow, nitrogen, zinc and oil and grease.
  2. The Laroche Chemicals Inc. facility in Gramercy, St. James Parish (Lake Borgne watershed) is the largest industrial discharger of Total Suspended Solids, Arsenic, Cadmium, Iron, Lead, and Mercury in the region.
  3. Waste water treatment plants are the major type of point source discharges.
- **Process Flow**
  Process flow is the flow originated from production processes in industrial facilities and the waste effluent from waste water treatment plants. In combined pipes (process, cooling, storm water runoff, etc), process flow for the pipe accounts only for the process fraction of the total flow. Process flow is the most important parameter in the inventory as an indicator of pollutant discharges from point sources. Below are some findings on this parameter:
  1. Four watersheds in the study area account for over 50 percent of the total process flow in the Gulf of Mexico (1,121 billion gallons): Galveston Bay 22 percent, Mississippi River 12 percent, Lake Borgne 9 percent and Sabine Lake 8 percent.
  2. The source of the process flow for the Galveston Bay and Mississippi River

watersheds is primarily WWTPs, while industry is the major source of process flow for the Lake Borgne and Sabine Lake watersheds.

3. The 79 power plants in the study area contribute about 71 percent of the total flow discharged from all point source categories (WWTP, industry and power plants). Most of this flow is once-through cooling water, which has little net addition of pollutants. However, some power plants have process water discharges that are comparable to loads discharged from major industrial activities.

- **Relative Contribution of Discharges For Total Nitrogen**
  A variety of relative contributions can be obtained using the inventory for each pollutant parameter. Below are some findings for total nitrogen:

  By Major Watershed:

  1. The watersheds with the largest discharges of total nitrogen in the study area (100 million pounds) are Galveston Bay (27 percent), and Mississippi River (16 percent).
  2. Total nitrogen discharges from major and minor point sources accounts for 29 percent in Galveston Bay, and 18 percent in Mississippi River.

  By State

  1. Texas accounts for 45 percent of total nitrogen discharges in the study area (100 million pounds), followed by Louisiana (35 percent), Florida (12 percent), Alabama (5 percent), Mississippi (2 percent) and Georgia (1 percent).

  By Discharge Activity:

  1. Eight percent of total nitrogen point source discharges in the entire region come from wastewater treatment plants, and only 20 percent from industries. Organic chemicals account for 25 percent of the total nitrogen discharges from industries, followed by petroleum refining, miscellaneous industrial plants, pesticides plants, inorganic chemicals, pulp and paper, phosphatic fertilizer, nitrogeneous fertilizers, nonferrous metals, and others.

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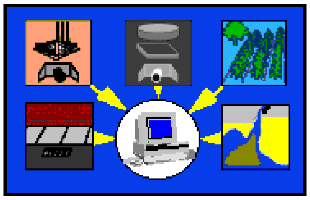

Challenges in Building and Interpreting a Point Source Regional Inventory

To build the Gulf of Mexico Inventory, pollution source information from many sources and of widely varying quality has to be compiled and synthesized into an integrated data set. The models, algorithms, decision rules, and simplifying assumptions used to develop loading estimates represent the best methods available to compile and process this diverse collection of data at a regional scale. The project team has tried to make the maximum use of available information, and to overcome the challenges of missing and unreliable data. It is important that users of the Inventory are aware of the limitations inherent in compiling and using a pollution source characterization at this scale. The most important of these are presented below.

- **Estimating Loads For All Facilities**
  Pollutant loads were estimated for all major and minor permitted and non-permitted point sources using NOAA's Point Source Loading Estimation Program (PSLEP). The amount of monitoring data available varied by pollutant, and industry type. Overall, monitoring data were generally available for Flow, BOD, TSS and phosphorus.

  Although a concerted effort was made to collect and use monitoring data, most of the pollutant discharge estimates, in particular for minor facilities in both countries, still rely heavily on typical pollutant concentration estimates. Because the inventory has a built-in audit trail, these typical estimates can be screened out by the user, which reduces the number of estimates available for analysis but increases the confidence level of the remaining values. The fact that the vast majority of permits for point source facilities in the study only require monitoring for a limited number of pollutants, it raises the question of whether monitoring for additional pollutants should be required, at least for the major facilities that contribute the bulk of the pollutant loadings. The inventory can be used to identify those major facilities for which additional permit requirements should be considered.

- **Assigning Facilities To Different Spatial Units**
  Spatial unit codes for pollutant aggregation purposes were assigned to all 8,913 facilities in the Gulf. When possible, the project team used the facility's latitude/longitude coordinates to identify its location. The latitude/longitude sources included the facility itself, state lists, EPA's PCS, hardcopy maps and EPA's Industrial Facility Discharge (IFD) database.
  However, when this information was not available, facility location was estimated using the coordinates of the facility's zip code or the centroid of the city. This lack of locational data, particularly for minor facilities, hindered the accurate assignment of facilities to individual subbasins.

- **Quantifying The Accuracy Of The Estimates**
  The inventory provides resource managers throughout the Gulf with an overall picture of pollution with reasonable accuracy, allowing them to develop appropriate pollution control strategies and monitoring programs. The inventory also provides resource managers with a tool to examine with confidence the relative contributions of point source pollutant discharges, both within and among watersheds.
  However, as discussed before, the capability to generate absolute accurate discharge estimates is limited by the scarcity of monitored pollutant data. For many pollutants, loads were based on assumptions about typical pollutant concentrations in the waste stream, volume of flow in the pipe, and the type of wastewater (e.g., process, cooling, a combination of both, or domestic sewage effluent) discharged. Download tpc_matrix.asc to see data.
  Although it was not possible to quantify the error by assigning numerical confidence limits to the estimates, by tagging each estimate with a data source and computational basis code, we have been able to provide the user with a means of evaluating the relative confidence that can be placed in the estimate.

- **Producing Timely Estimates**
  The inventory is a snapshot in time -- a picture of pollution discharges in 1991. These loading estimates can be considered reasonably representative of discharges from 1992 to 1995, particularly for screening-level assessments. In general, this assumption is better for discharges from wastewater treatment plants, which vary less over time, than from industrial activities, which are more sensitive to changes in production levels tied to economic conditions.
  However, in many instances, a more recent inventory that is representative of discharges for a current year is required. NOAA has now acquired a capability to estimate loads that are only two years old in a short period of time (2-3 months) making use of its recently updated PSLEP algorithm.

- **Compiling a Comprehensive Inventory**
  The project team made an extensive effort to generate a comprehensive inventory of facilities in the Gulf of Mexico and believes the inventory contains a fairly complete listing of the dischargers in the study area for the given year. However, in such a large study area in any given time period, some facilities begin or change operations, others cease operating permanently, and some change ownership and name. Resolving discrepancies in the exact number, type, and discharge characteristics of facilities in an area is time- consuming and often unsuccessful. The accuracy of the information can continue to improve when future inventories are developed.

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Gulf of Mexico Land-Based Pollution Sources Inventory

Nonpoint Sources of Pollution

Nonpoint Source Inventory
This nonpoint source inventory has been developed for the Gulf of Mexico study area using an integrated approach which includes: 1) a watershed model to obtain urban and non-urban pollutant loads; 2) a geographic information system (GIS) interfaced with the watershed model to collect, manage, analyze, and display the spatial and temporal inputs and outputs; and 3) a relational database to manage the nonspatial data.

The SWAT Model

- **SWAT.-** The watershed-scale modeling capability called the Soil and Water Assessment Tool (SWAT) model has been developed jointly by the United States Department of Agriculture (USDA)'s Agricultural Service and Texas A & M's Agricultural Experiment Station in Temple, Texas, in close cooperation with the project team. This model is a continuous time, daily, long-term simulation, lumped parameter, deterministic model that has a reasonable computation burden. SWAT combines a watershed model known as "Simulator for Water Resources and Rural Basins (SWRRB)" and a river routing model called "Routing Outputs to Outlets (ROTO)." The computational components of SWAT can be placed into eight major divisions: hydrology, weather, sedimentation, soil temperature, crop growth, nutrients, pesticides, and agricultural management. The major model components of the hydrologic mass balance simulated by SWAT include surface runoff, lateral flow in the soil profile, groundwater flow, evapotranspiration, channel routing, pond and reservoir storage.

- **Non-urban Nonpoint Source Model.-** The SWAT model estimates surface runoff volume from non-urban areas using the Soil Conservation Service (SCS) curve number procedure. Sediment yield from rural basins is computed using the Modified Universal Soil Loss Equation (MUSLE). Nutrient yield and nutrient cycling use the algorithms developed for the EPIC model (3) and modified as necessary while included into the SWAT model. SWAT allows for simultaneous computations on each subbasin and routes the water, sediment and nutrients from the subbasin outlets to the basin outlet (4).

- **Urban Nonpoint Source Model.-** To obtain runoff estimates and nonpoint source yields from urban areas the Urban Storm Runoff Loading Model developed by Tasker and Driver (1988), United States Geological Service (USGS) was used (5). Depending on average annual rainfall (<508 mm/year, 508-1,016 mm/year, and >

1,016 mm/year), one of three regions of the U.S. was selected for specific regional regressions. The three parameter equations which use imperviousness, precipitation, and drainage areas was selected. Imperviousness used was estimated from percent cover of residential, industrial, and commercial land uses. Inorganic nitrogen was assumed to be the difference between total nitrogen and Keljdahl nitrogen. Total Keljdahl nitrogen was the sum of ammonium and organic nitrogen.

- **Modeling Unit.-** The spatial unit for SWAT modeling in the Gulf of Mexico is the modeling unit called "UNIQUE" in NOAA's Coastal Assessment Framework (USGS 8-digit Cataloging Unit and Estuarine Drainage Area intersection area). Precipitation, soils, elevation, and geology within uniques are assumed to be homogeneous.

- **Climate.-** Climate data were obtained by processing the National Climatic Data Center (NCDC) daily precipitation (mm), maximum and minimum temperatures (deg. C) in each unique for the 1989 to 1995 period. Missing values for weather stations were filled by the closest station within a 70 miles radius. If there were still missing values, they were fixed using the WGEN weather generator (6). Representative climate data were obtained by averaging all weather stations within the modeling unit (unique).

- **Land Use and Soils.-** The land use/cover map use was the USGS LUDA data derived from photographic and LANDSAT observations during the 1980s improved with 1990 Census population to better characterize current urban areas. Since the land use/cover map did not discern crops in agricultural areas, the percent cover of crops from the county intersection of Census of Agriculture for 1992 (7) with SWAT uniques was derived. From the STATSGO soils map, ranked percent composition of generalized soil polygons in each SWAT unique watershed was assigned in descending order to ranked census crops (the so-called dominant-dominant selection of crops and soils). The SWAT model uses soil bulk density, wilting point, soil texture, and saturated hydraulic conductivity to balance the daily soil-moisture in each soil layer based on soil water evaporation, plant water use, and gravity flow. Soil water evaporation depends on the potential evaporative demand, available soil water, soil residue cover, and wet and dry albedo. Cracking of soils during high evaporative periods is controlled by soil organic carbon (8).

- The types of crop selected for use in SWAT ranged from potatoes to major crop growth and row crops, to vegetables (grouped together as "specialty" crops). Three types of forest cover were used: evergreen, deciduous, and mixed forests. For crop growth routines, automatic fertilizer application on croplands was assumed (i.e, the plant uptakes the necessary nutrients from the soil when nutrient stress is above 0.5).

- **Geology.-** The SWAT model uses the baseflow recession constant to lag water flow past the root zone (8). Since a consistent and complete surficial aquifer map for all states in the the Gulf was not available, a 1:7.5M surficial aquifer map developed by Heath R.C. (9) was used to impute baseflow recession constants by stratified hydro-geologic zones (10). Wheather more detailed (1:24,000) surficial aquifer data would provide beter SWAT hydrographs has yet to be investigated.

- **Routing.-** The SWAT stream routing requires the height and width of rectangular channels during two-year return flows. A neural network model developed by Texas

A&M (11) was used to estimate channel dimensions from modeling unit elevations and drainage areas. The SWAT model uses the storage coeffcient method (8) to route water thrrough streams. At confluence points, water flow is added algebraically. Sediment is suspended and carried in streams using Bagnold's power function and particles reaching the bottom of streams according to Stokes' formula. In-stream nutrient kinetics are controlled by QUAL-2E routines which uses time of travel in reach segments (8).

- **Reservoirs.-** All reservoirs from the National Inventory of Dams (12) were aggregated to main stem and tributary reservoirs. The SWAT model required data on principle spillway surface area (ha), runoff required to fill principle spillway (ha-m), seepage through dam (m3/day), initial sediment concentration (assumed at 400 ppm), and months for start and end of flooding periods.

  Snow Melt Model.- The SWAT model uses the average air temperature (Tair) above a base temperature (0 deg. C) to model snow melt (degree-day method):

  snow melt (mm/day) = 4.57 Tair

- Acknoledging that spatial variability of precipitation during snofall events is important, especially in mountainous terrain, we used the FCPACK19 NOAA-National Weather Service model temperature index model (13). to melt and area deplete snow water in modeling units (SWAT melts snow directly to the subbasin outlet). The NOAA-NWS model typically uses 6-hour air temperatures (we used 24-hour averages) as the index to energy exchange across the snow-air interface and accounts for freezing water due to heat deficit, retention, and transmission of liquid-water.

- **Point Sources.-** NOAA's Gulf of Mexico point source database provides 1991 estimates of seasonal and annual pollutant loadings for each active facility that discharges to surface waters. For input to the SWAT model, monthly point source discharges on flow, nitrate-N, nitrite-N, ammonium-N, organic-N, and phosphorus were obtained from seasonal values. Point sources data in each modeling unit (unique) were cumulated to monthly modeling unit values, and daily values were generated by dividing the monthly value by the number of days per month. Subroutines were written in SWAT's routing component to input point sources directly to streams.

- **Upstream Sources.-** NOAA's Gulf of Mexico upstream source database provides 1991 estimates of seasonal and annual flow and pollutant loads at the stream point of entrance to the Gulf of Mexico study area. These estimates were incorported into SWAT to account for pollutant loading estimates not generated by SWAT above the study area.

- **GIS Interface**

  An important feature of the SWAT model is the GIS interface developed in the Geographical Resources Analysis Support System (GRASS) that allows the user to extract model input from map layers for each modeling unit. The input interface programs and other tools are written in the compiled language C, and are integrated with the GRASS libraries (14). The model itself is written in FORTRAN 77, and both the interface and model run within the UNIX environment.

Infrastructure and Relational Database for the Gulf of Mexico

The SWAT model operates in a selected modeling unit (unique). Modeling units can be aggregated up to a USGS Cataloging Unit and to a major watershed in the Gulf of Mexico.

In the Gulf of Mexico study area there are 146 modeling units (unique). The model inputs such as land use, climate, soil properties, and topography are derived for each "unique" area. The model then estimates runoff volume, sediment and nutrient (nitrogen and phosphorus) discharge for up to 19 landuses virtual basins for each subbasin (5 irrigated and 5 non-irrigated crops, rangeland shrub and brush, rangeland herbaceous, forest deciduous, forest evergreen, forest mixed, urban, wetland forested, wetland non-forested, and water). The simulation is for a six-year period (1989-1995).

All the input and output files from the SWAT model have been interfaced with the Statistical Analysis System (SAS) relational database framework for analysis, data manipulation and reporting. The spatial databases are stored in GRASS and ARCVIEW and they can be easily exported out to ARCINFO data exchange E00 format.

The SWAT model is continually being refined and adapted to a wider range of hydrologic and environmental problem solving abilities. For the Gulf of Mexico project, it has been updated to include improvements for urban runoff, snow melt and selection of crops from agricultural lands using the U.S. Department of Agriculture's Agricultural Census database (AGCENSUS).

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Nonpoint Sources of Pollution

Results of the 1991 Nonpoint Source Inventory

- The SWAT model was run using climate data from 1985 to 1995. The output from 1985 to 1988 was not used due to errors with initial soil-water and soil-nutrient conditions. Unfortunately, measured sediment and nutrient loadings are scarce for the basins, reason why a validation analyses was not conducted.

- The SWAT model output results of local contributions (i.e. within a unique) by land use are provided in the GU_SBS file. The aggregated data by subbasin are provided in the GU_BSB file. Stream reach SWAT model output results are provided in the GU_RCH file. If a UNIQUE has upstream contributions then loads for this unique will include the accumulated loads from all upstream uniques that make up the total drainage area. Total nitrogen is the sum of organic nitrogen in sediment, nitrogen in surface runoff, and nitrogen in subsurface flow. Total phosphorus is the sum of soluble phosphorus and phosphorus attached to sediment. The TSS was taken as SWAT sediment yield.

- The SWAT model generates many types of nonpoint source files. Only the most important files are provided as deliverable files.

- SWAT model results from the SBS file were compared with literature values. There is some uncertainty in the use of literature values, since it most probably includes detects. The SWAT model reports the complete nonpoint source and flow picture for the entire climate regime. Therefore, SWAT values less than literature values were denoted "okay". Total nitrogen yield (lbs/acre/year), total phosphorus yield (lbs/acre/year) and total suspended solids (TSS) yield (lbs/acre/year) estimates were computed for this purpose.

- SWAT model results from the RCH file were compared with literature values. Nonpoint source pollutant concentration (mg/L) estimates in reaches (Ammonium and organic nitrogen, nitrite and nitrate, total phosphorus, and total suspended solids) were computed for this purpose.

- Nonpoint source loads by year and source were produced for Total Flow and its components (surface flow, lateral flow and groundwater flow), TSS, Total Nitrogen, and Total Phosphorus. Agriculture was the primary source of loads for all parameters except Flow which did not exhibit a dominant source. For the record period 1989-

1995, SWAT consistently generated annual loads from agriculture in excess of two billion pounds, six million pounds, and 200,000 pounds for TSS, Total Nitrogen, and Total Phosphorus, respectively.

- Nonpoint source loads by watershed (EDA/CDA) for 1991 were also produced for Total Flow and its components (surface flow, lateral flow and groundwater flow), TSS, Total Nitrogen, and Total Phosphorus. Listed below are the top ten dischargers of each parameter.

  Total Flow

  Barataria Bay, Terrebonne/Timbalier Bays, Atchafalaya/Vermilion Bays, Lake Pontchartrain, Sabine Lake, Mermentau River, Apalachee Bay, St. Andrew River, Brazos River, Galveston Bay

  TSS

  Baffin Bay, Corpus Christi Bay, Mermentau River, Galveston Bay, Brazos River, Lake Pontchartrain, Matagorda Bay, Atchafalaya/Vermilion Bays, Lower Laguna Madre, Apalachee Bay

  Total Nitrogen

  Galveston Bay, Matagorda Bay, Brazos River, Lake Pontchartrain, Mermentau River, Baffin Bay, Atchafalaya/Vermilion Bays, Sabine Lake, Apalachee Bay, Corpus Christi Bay

  Total Phosphorus

  Galveston Bay, Baffin Bay, Brazos River, Mermentau River, Corpus Christi Bay, Lake Pontchartrain, Matagorda Bay, Atchafalaya/Vermilion Bays, Breton/Chandelur Sound, Apalachee Bay

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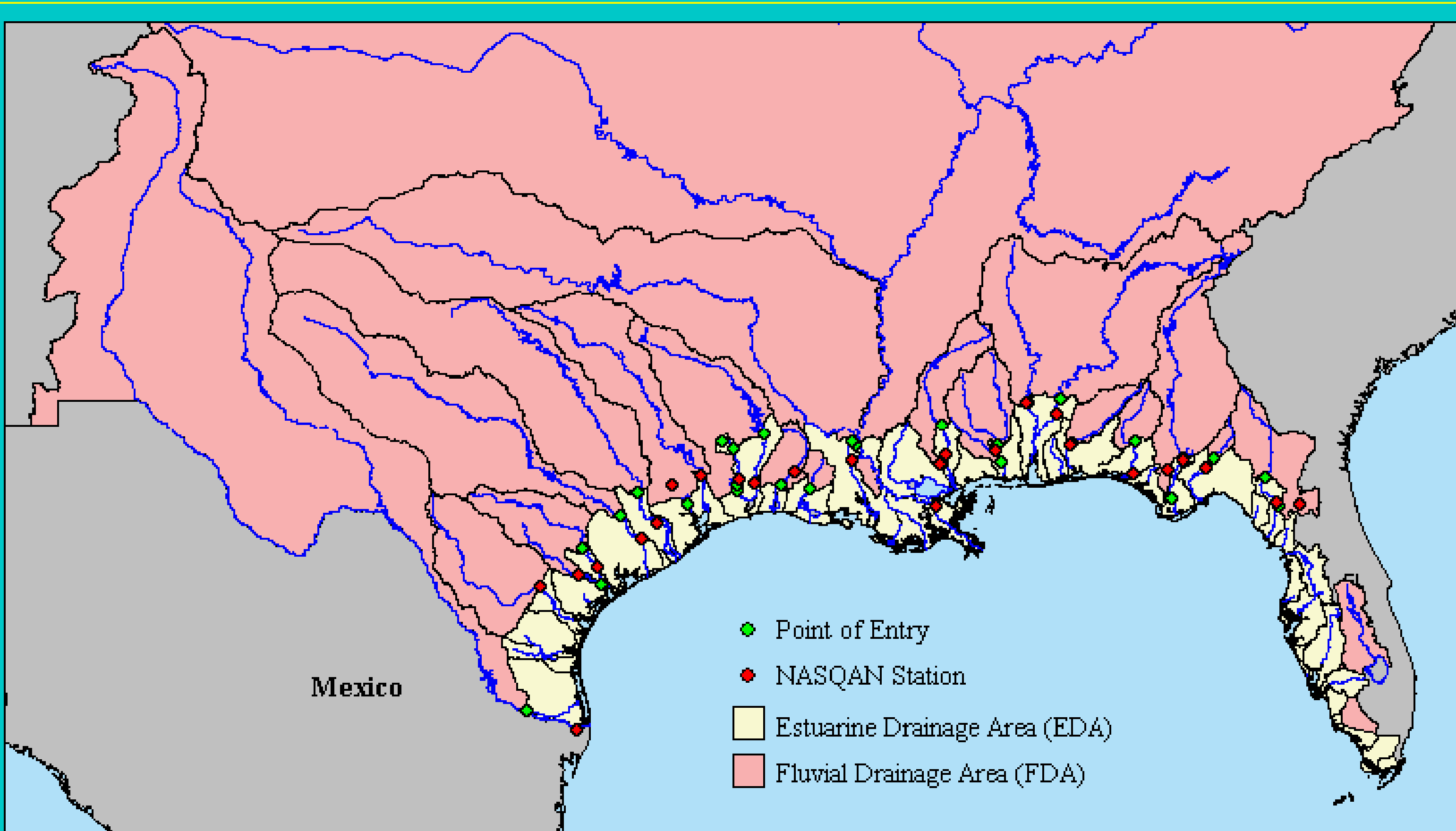
Upstream Sources Point of Entry to Study Area (Estuarine Drainage Area [EDA])



Gulf of Mexico Land-Based Pollution Sources Inventory

Nonpoint Sources of Pollution

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- **Geology.-** The SWAT model uses the baseflow recession constant to lag water flow past the root zone (8). Since a consistent and complete surficial aquifer map for all states in the the Gulf was not available, a 1:7.5M surficial aquifer map developed by Heath R.C. (9) was used to impute baseflow recession constants by stratified hydro-geologic zones (10). Wheather more detailed (1:24,000) surficial aquifer data would provide beter SWAT hydrographs has yet to be investigated.

- **Routing.-** The SWAT stream routing requires the height and width of rectangular channels during two-year return flows. A neural network model developed by Texas

A&M (11) was used to estimate channel dimensions from modeling unit elevations and drainage areas. The SWAT model uses the storage coeffcient method (8) to route water thrrough streams. At confluence points, water flow is added algebraically. Sediment is suspended and carried in streams using Bagnold's power function and particles reaching the bottom of streams according to Stokes' formula. In-stream nutrient kinetics are controlled by QUAL-2E routines which uses time of travel in reach segments (8).

- **Reservoirs.-** All reservoirs from the National Inventory of Dams (12) were aggregated to main stem and tributary reservoirs. The SWAT model required data on principle spillway surface area (ha), runoff required to fill principle spillway (ha-m), seepage through dam (m3/day), initial sediment concentration (assumed at 400 ppm), and months for start and end of flooding periods.

Snow Melt Model.- The SWAT model uses the average air temperature (Tair) above a base temperature (0 deg. C) to model snow melt (degree-day method):

snow melt (mm/day) = 4.57 Tair

- Acknoledging that spatial variability of precipitation during snofall events is important, especially in mountainous terrain, we used the FCPACK19 NOAA-National Weather Service model temperature index model (13). to melt and area deplete snow water in modeling units (SWAT melts snow directly to the subbasin outlet). The NOAA-NWS model typically uses 6-hour air temperatures (we used 24-hour averages) as the index to energy exchange across the snow-air interface and accounts for freezing water due to heat deficit, retention, and transmission of liquid-water.

- **Point Sources.-** NOAA's Gulf of Mexico point source database provides 1991 estimates of seasonal and annual pollutant loadings for each active facility that discharges to surface waters. For input to the SWAT model, monthly point source discharges on flow, nitrate-N, nitrite-N, ammonium-N, organic-N, and phosphorus were obtained from seasonal values. Point sources data in each modeling unit (unique) were cumulated to monthly modeling unit values, and daily values were generated by dividing the monthly value by the number of days per month. Subroutines were written in SWAT's routing component to input point sources directly to streams.

- **Upstream Sources.-** NOAA's Gulf of Mexico upstream source database provides 1991 estimates of seasonal and annual flow and pollutant loads at the stream point of entrance to the Gulf of Mexico study area. These estimates were incorported into SWAT to account for pollutant loading estimates not generated by SWAT above the study area.

- **GIS Interface**

An important feature of the SWAT model is the GIS interface developed in the Geographical Resources Analysis Support System (GRASS) that allows the user to extract model input from map layers for each modeling unit. The input interface programs and other tools are written in the compiled language C, and are integrated with the GRASS libraries (14). The model itself is written in FORTRAN 77, and both the interface and model run within the UNIX environment.

Infrastructure and Relational Database for the Gulf of Mexico

The SWAT model operates in a selected modeling unit (unique). Modeling units can be aggregated up to a USGS Cataloging Unit and to a major watershed in the Gulf of Mexico.

In the Gulf of Mexico study area there are 146 modeling units (unique). The model inputs such as land use, climate, soil properties, and topography are derived for each "unique" area. The model then estimates runoff volume, sediment and nutrient (nitrogen and phosphorus) discharge for up to 19 landuses virtual basins for each subbasin (5 irrigated and 5 non-irrigated crops, rangeland shrub and brush, rangeland herbaceous, forest deciduous, forest evergreen, forest mixed, urban, wetland forested, wetland non-forested, and water). The simulation is for a six-year period (1989-1995).

All the input and output files from the SWAT model have been interfaced with the Statistical Analysis System (SAS) relational database framework for analysis, data manipulation and reporting. The spatial databases are stored in GRASS and ARCVIEW and they can be easily exported out to ARCINFO data exchange E00 format.

The SWAT model is continually being refined and adapted to a wider range of hydrologic and environmental problem solving abilities. For the Gulf of Mexico project, it has been updated to include improvements for urban runoff, snow melt and selection of crops from agricultural lands using the U.S. Department of Agriculture's Agricultural Census database (AGCENSUS).

Results of the 1991 Nonpoint Source Inventory

- The SWAT model was run using climate data from 1985 to 1995. The output from 1985 to 1988 was not used due to errors with initial soil-water and soil-nutrient conditions. Unfortunately, measured sediment and nutrient loadings are scarce for the basins, reason why a validation analyses was not conducted.

- The SWAT model output results of local contributions (i.e. within a unique) by land use are provided in the GU_SBS file. The aggregated data by subbasin are provided in the GU_BSB file. Stream reach SWAT model output results are provided in the GU_RCH file. If a UNIQUE has upstream contributions then loads for this unique will include the accumulated loads from all upstream uniques that make up the total drainage area. Total nitrogen is the sum of organic nitrogen in sediment, nitrogen in surface runoff, and nitrogen in subsurface flow. Total phosphorus is the sum of soluble phosphorus and phosphorus attached to sediment. The TSS was taken as SWAT sediment yield.

- The SWAT model generates many types of nonpoint source files. Only the most important files are provided as deliverable files.

- SWAT model results from the SBS file were compared with literature values. There is some uncertainty in the use of literature values, since it most probably includes detects. The SWAT model reports the complete nonpoint source and flow picture for the entire climate regime. Therefore, SWAT values less than literature values were denoted "okay". Total nitrogen yield (lbs/acre/year), total phosphorus yield (lbs/acre/year) and total suspended solids (TSS) yield (lbs/acre/year) estimates were computed for this purpose.

- SWAT model results from the RCH file were compared with literature values. Nonpoint source pollutant concentration (mg/L) estimates in reaches (Ammonium and organic nitrogen, nitrite and nitrate, total phosphorus, and total suspended solids) were computed for this purpose.

- Nonpoint source loads by year and source for the study area were produced for Flow, TSS, Total Nitrogen, and Total Phosphorus. Agriculture was the primary source of loads for all parameters except Flow which did not exhibit a dominant source. For the record period 1989-1995, SWAT consistently generated annual loads from agriculture in excess of two billion pounds, six million pounds, and 200,000 pounds for TSS, Total Nitrogen, and Total Phosphorus, respectively.

- Nonpoint source loads by watershed (EDA/CDA) for 1991 for the study area were also produced for Flow, TSS, Total Nitrogen, and Total Phosphorus. Listed below are the top ten dischargers of each parameter.

  Flow

  Barataria Bay, Terrebonne/Timbalier Bays, Atchafalaya/Vermilion Bays, Lake Pontchartrain, Sabine Lake, Mermentau River, Apalachee Bay, St. Andrew River, Brazos River, Galveston Bay

  TSS

  Baffin Bay, Corpus Christi Bay, Mermentau River, Galveston Bay, Brazos River, Lake Pontchartrain, Matagorda Bay, Atchafalaya/Vermilion Bays, Lower Laguna Madre, Apalachee Bay

  Total Nitrogen

  Galveston Bay, Matagorda Bay, Brazos River, Lake Pontchartrain, Mermentau River, Baffin Bay, Atchafalaya/Vermilion Bays, Sabine Lake, Apalachee Bay, Corpus Christi Bay

  Total Phosphorus

  Galveston Bay, Baffin Bay, Brazos River, Mermentau River, Corpus Christi Bay, Lake Pontchartrain, Matagorda Bay, Atchafalaya/Vermilion Bays, Breton/Chandelur Sound, Apalachee Bay

Gulf of Mexico Land-Based Pollution Sources Inventory

The National Coastal Pollutant Discharge Inventory: A National Point Source Methods Document

This document describes the data sources and methods used to develop an inventory of direct-discharging point sources in the coastal watersheds of the Nation, as part of NOAA's National Coastal Pollutant Discharge Inventory (NCPDI). The inventory contains estimates of seasonal and annual pollutant loadings for 1991 for each active pipe discharging pollutants to surface waters, along with location and operational characteristics of the point source facilities in the study area.

Please, direct comments, questions, or problems related to the NCPDI Point Source Inventory to

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If you would like to receive a copy of the National Point Source Methods Document, please contact our editor,

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Variables in Facility File (G_FILE1.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
NPID	NPDES Number	character	9
FNML	Facility Name as in PCS	character	120
FACILNM	Standardized Facility Name	character	40
MADI	Major Discharge Indicator	character	1
MRAT	Major Rating Code	character	3
FLOW	Average Flow (MGD)	character	5
STTE	State Abbreviation	character	2
STATE	State FIPS Code	character	2
FIPS	FIPS Code (State + County)	character	5
CITY	City Code	character	5
CYNM	City Name	character	20
CNTY	County Code	character	3
CNTYNM	County name	character	40
CNTYSORS	County Code Source Code	character	1
FCU	Facility Catloging Unit	character	8
FCUSORS	Facility Cataloging Unit Source Code	character	1
EDACODE	EDA/CDA Code	character	5
EDANAME	EDA/CDA Name	character	60
EDASORS	EDA Source Code	character	4
FLAT	Facility - Latitude (DDMNSS)	character	6
FLAT1	Facility - Latitude Decimal Degrees	numeric	8
FLON	Facility - Longitude (DDDMNSS)	character	7
FLON1	Facility - Longitude Decimal Degrees	numeric	8
FLLSORS	Facility lat/long source code	character	1
REAC	River Reach Number	character	12
RWAT	Receiving Water	character	35
SIC	SIC code	character	4
SICDG	SIC Division Code	character	1
SICIG	SIC Industry Group Code	character	3

SICMG	SIC Major Group Code	character	2
SICNM	SIC Name	character	40
EPST	Type of Permit Issued - EPA/State	character	1
EXMY	Expiration Date	character	5
FFID	Federal Facility Identification Number	character	12
GPCT	General Permit Industrial Category	character	2
IACC	Facility Inactive Code	character	1
IADT	Facility Inactive Date	character	6
PRET	Pretreatment Program Required Indicator	character	1
TYPA	Type of Application	character	2
TYPO	Type of Ownership	character	3
INCL	Industry Classification	character	1
DCCD	NOAA Discharge Category Code	character	4
DCNM	NOAA Discharge Category Name	character	30
EPAINDCD	EPA Discharge Category Code	character	2
EPAINDNM	EPA Discharge Category Name	character	25
PS	Point Sources Category	character	1
MST1	Primary Mailing Street Line 1	character	30
MST2	Primary Mailing Street Line 2	character	30
MSTT	Primary Mailing State	character	2
MZIP	Primary Mailing ZIP Code	character	9
RST1	Facility Location Street Line 1	character	30
RST2	Facility Location Street Line 2	character	30
RZIP	Facility Location ZIP Code	character	9
RTEL	Facility Location Telephone Number	character	10
OFFL	Cognizant Official Name	character	30
TELE	Cognizant Official Telephone	character	10
STBA	Standard Basis	character	1
REGION	Region Code	character	1
UNIQUE	Unique Code in CAF	numeric	8

Variables in Monthly Discharge Monitoring Report (DMR) File (G_FILE2.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
NPID	NPDES NUMBER	character	9
DSCH	DISCHARGE NUMBER	character	3
PDSG	LIMIT DISCHARGE NUMBER/REPORT DESIGNATOR	character	4
MLOC	MONITORING LOCATION	character	1
SEASON	SEASON CODE	character	1
MONTH	MONTH CODE	character	2
MDML	MINIMUM NUMBER OF DMR LINES	character	2
PRAM	PARAMETER CODE	character	5
RCUN	REPORTED CONC. UNIT	character	2
RUNT	REPORTED QUANT. UNIT	character	2
MVDT	MEASUREMENT/VIOL. - MON.PERIOD END DATE	character	6
NODI	NO DATA INDICATOR	character	1
LCUC	CONC. UNIT CODE	character	2
LQUC	QUANT. UNIT CODE	character	2
MCAV	MEASUREMENT/VIOLATION - CONC. AVERAGE	character	8
MCMX	MEASUREMENT/VIOLATION - CONC. MAXIMUM	character	8
MCMN	MEASUREMENT/VIOLATION - CONC. MINIMUM	character	8
MQAV	MEASUREMENT/VIOLATION - QUANT. AVERAGE	character	8
MQMX	MEASUREMENT/VIOLATION - QUANT. MAXIMUM	character	8
MCAV1	MEASUREMENT/VIOLATION - CONC. AVERAGE	numeric	8
MCMX1	MEASUREMENT/VIOLATION - CONC. MAXIMUM	numeric	8
MCMN1	MEASUREMENT/VIOLATION - CONC. MINIMUM	numeric	8
MQAV1	MEASUREMENT/VIOLATION - QUANT. AVERAGE	numeric	8
MQMX1	MEASUREMENT/VIOLATION - QUANT. MAXIMUM	numeric	8

Variables in Permit Requirements and Loading File (G_FILE3.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
NPID	NPDES NUMBER	character	9
DSCH	DISCHARGE NUMBER	character	3
PDSG	LIMIT DISCHARGE NUMBER/REPORT DESIGNATOR	character	4
PIPE	PIPE DESCRIPTION	character	30
MLOC	MONITORING LOCATION	character	1
PRAM	PARAMETER CODE	character	5
SAMP	SAMPLE TYPE	character	2
TRET	TREATMENT TYPES	character	24
WAST	TYPE OF EFFLUENT WASTE	character	2
WQUA	WATER QUALITY LIMITS INDICATOR	character	1
PIAC	PIPE INACTIVE CODE	character	1
PLAT	PIPE LATITUDE - DEGREES,MINUTES,SECONDS	character	8
PLAT1	PIPE LATITUDE - DECIMAL DEGREES	numeric	8
PLON	PIPE LONGITUDE - DEGREES,MINUTES,SECONDS	character	9
PLON1	PIPE LONGITUDE - DECIMAL DEGREES	numeric	8
LQAV	QUANTITY AVERAGE LIMIT	character	8
LQMX	QUANTITY MAXIMUM LIMIT	character	8
LQUC	QUANTITY UNIT CODE	character	2
LCAV	CONCENTRATION AVERAGE LIMIT	character	8
LCMX	CONCENTRATION MAXIMUM LIMIT	character	8
LCMN	CONCENTRATION MINIMUM LIMIT	character	8
LCUC	CONCENTRATION UNIT CODE	character	2
LQAV1	STANDARDIZED QUANTITY AVERAGE LIMIT	numeric	8
LQMX1	STANDARDIZED QUANTITY MAXIMUM LIMIT	numeric	8
LQUC1	STANDARDIZED QUANTITY UNIT CODE	character	2
LCAV1	STANDARDIZED CONCENTRATION AVERAGE LIMIT	numeric	8
LCMX1	STANDARDIZED CONCENTRATION MAXIMUM LIMIT	numeric	8
LCMN1	STANDARDIZED CONCENTRATION MINIMUM LIMIT	numeric	8
LCUC1	STANDARDIZED CONCENTRATION UNIT CODE	character	2

FLOWMGD	FLOW IN MILLION GALLONS PER DAY	numeric	8
FLOWBASE	POLL.LOAD BASIS CODE-DETAILED DESC.FLOW	character	2
LOAD	POLLUTANT LOAD	numeric	8
LOADBASE	POLL.LOAD BASIS CODE-DETAILED DESC.LOAD	character	2
UNITSCD	POLLUTANT LOAD UNITS CODE	character	2

Variables in the Discharge Monitoring Report (DMR) Loadings File (G_FILE4.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
NPID	NPDES NO.	character	9
DSCH	DISCHARGE NO.	character	3
PDSG	LIMIT DISCHARGE NO./REPORT DESIGNATOR	character	4
MLOC	MONITORING LOCATION	character	1
PRAM	PARAMETER CODE	character	5
NODI	NO DATA INDICATOR	character	1
MDML	MINIMUM NO. OF DMR LINES	character	2
MQAV_N	MEAS.QUANT. AVERAGE - NO.OF OBS.	numeric	8
MQAV_NMI	MEAS.QUANT. AVERAGE - NO. MISS. VALUES	numeric	8
MQAV_MIN	MEAS.QUANT. AVERAGE - MINIMUM VALUE	numeric	8
MQAV_MAX	MEAS.QUANT. AVERAGE - MAXIMUM VALUE	numeric	8
MQAV_RAN	MEAS.QUANT. AVERAGE - RANGE	numeric	8
MQAV_AVE	MEAS.QUANT. AVERAGE - ANNUAL AVERAGE	numeric	8
MQAV_STD	MEAS.QUANT. AVERAGE - STAND. DEVIATION	numeric	8
MQAV_CV	MEAS.QUANT. AVERAGE - CV (LARGE SAMPLE)	numeric	8
MQAV_CV1	MEAS.QUANT. AVERAGE - CV (SMALL SAMPLE)	numeric	8
MQMX_N	MEAS.QUANT. MAXIMUM - NO. OF OBS.	numeric	8
MQMX_NMI	MEAS.QUANT. MAXIMUM - NO. MISS. VALUES	numeric	8
MQMX_MIN	MEAS.QUANT. MAXIMUM - MINIMUM VALUE	numeric	8
MQMX_MAX	MEAS.QUANT. MAXIMUM - MAXIMUM VALUE	numeric	8
MQMX_RAN	MEAS.QUANT. MAXIMUM - RANGE	numeric	8
MQMX_AVE	MEAS.QUANT. MAXIMUM - ANNUAL AVERAGE	numeric	8
MQMX_STD	MEAS.QUANT. MAXIMUM - STAND. DEVIATION	numeric	8
MQMX_CV	MEAS.QUANT. MAXIMUM - CV (LARGE SAMPLE)	numeric	8
MQMX_CV1	MEAS.QUANT. MAXIMUM - CV (SMALL SAMPLE)	numeric	8
RUNT	REPORTED QUANT. UNIT	character	2
MCAV_N	MEAS. CONC. ALL AVERAGE - NO. OF OBS.	numeric	8
MCAV_NMI	MEAS. CONC. AVERAGE - NO. MISS. VALUES	numeric	8

MCAV_MIN	MEAS. CONC. AVERAGE - MINIMUM VALUE	numeric	8
MCAV_MAX	MEAS. CONC. AVERAGE - MAXIMUM VALUE	numeric	8
MCAV_RAN	MEAS. CONC. AVERAGE - RANGE	numeric	8
MCAV_AVE	MEAS. CONC. AVERAGE - ANNUAL AVERAGE	numeric	8
MCAV_STD	MEAS. CONC. AVERAGE - STAND. DEVIATION	numeric	8
MCAV_CV	MEAS. CONC. AVERAGE - CV (LARGE SAMPLE)	numeric	8
MCAV_CV1	MEAS. CONC. AVERAGE - CV (SMALL SAMPLE)	numeric	8
MCMX_N	MEAS. CONC. MAXIMUM - NO. OF OBS.	numeric	8
MCMX_NMI	MEAS. CONC. MAXIMUM - NO. MISS. VALUES	numeric	8
MCMX_MIN	MEAS. CONC. MAXIMUM - MINIMUM VALUE	numeric	8
MCMX_MAX	MEAS. CONC. MAXIMUM - MAXIMUM VALUE	numeric	8
MCMX_RAN	MEAS. CONC. MAXIMUM - RANGE	numeric	8
MCMX_AVE	MEAS. CONC. MAXIMUM - ANNUAL AVERAGE	numeric	8
MCMX_STD	MEAS. CONC. MAXIMUM - STAND. DEVIATION	numeric	8
MCMX_CV	MEAS. CONC. MAXIMUM - CV (LARGE SAMPLE)	numeric	8
MCMX_CV1	MEAS. CONC. MAXIMUM - CV (SMALL SAMPLE)	numeric	8
MCMN_N	MEAS. CONC. MINIMUM - NO. OF OBS.	numeric	8
MCMN_NMI	MEAS. CONC. MINIMUM - NO. MISS. VALUES	numeric	8
MCMN_MIN	MEAS. CONC. MINIMUM - MINIMUM VALUE	numeric	8
MCMN_MAX	MEAS. CONC. MINIMUM - MAXIMUM VALUE	numeric	8
MCMN_RAN	MEAS. CONC. MINIMUM - RANGE	numeric	8
MCMN_AVE	MEAS. CONC. MINIMUM - ANNUAL AVERAGE	numeric	8
MCMN_STD	MEAS. CONC. MINIMUM - STAND. DEVIATION	numeric	8
MCMN_CV	MEAS. CONC. MINIMUM - CV (LARGE SAMPLE)	numeric	8
MCMN_CV1	MEAS. CONC. MINIMUM - CV (LARGE SAMPLE)	numeric	8
RCUN	REPORTED CONC. UNIT	character	2
MQAV1	STANDARDIZED MONITORED QUANT. AVERAGE	numeric	8
MQMX1	STANDARDIZED MONITORED QUANT. MAXIMUM	numeric	8
RUNT1	STANDARDIZED MONITORED QUANT. UNIT CODE	character	2
MCAV1	STANDARDIZED MONITORED CONC. AVERAGE	numeric	8
MCMX1	STANDARDIZED MONITORED CONC. MAXIMUM	numeric	8
MCMN1	STANDARDIZED MONITORED CONC. MINIMUM	numeric	8

RCUN1	STANDARDIZED MONITORED CONC. UNIT CODE	character	2
FLOWMGD	FLOW IN MILLION GALLONS PER DAY	numeric	8
FLOWBASE	POLL. BASIS CODE - DETAILED DES. FLOW	character	2
FLOWCV	FLOW - CV (LARGE SAMPLE)	numeric	8
FLOWN	FLOW - NO. OF OBS.	numeric	8
LOAD	POLLUTANT LOAD	numeric	8
LOADBASE	POLLUTANT LOAD BASIS CODE	character	2
MASSCV	CV (LARGE SAMPLE) FOR MASS VALUE	numeric	8
MASSN	NO. OF OBS. FOR MASS VALUE	numeric	8
CONCCV	CONC. VALUE - CV (LARGE SAMPLE)	numeric	8
CONCN	CONC. VALUE - NO. OF OBS.	numeric	8
UNITSCD	POLL. LOAD UNITS CODE	character	2

Variables in Typical Pollutant Concentration (TPC) Loadings File (G_FILE5.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
NPID	NPDES NUMBER	character	9
DSCH	DISCHARGE NUMBER	character	3
PDSG	LIMIT DISCH. NO./REPORT DESIGNATOR	character	4
MADI	MAJOR DISCHARGE INDICATOR	character	1
SIC	SIC CODE - 1987 FACILITY DESCRIPTION	character	4
SICMG	SIC MAJOR GROUP CODE	character	2
SICIG	SIC INDUSTRY GROUP CODE	character	3
SICDG	SIC DIVISION CODE	character	1
SICNM	SIC NAME	character	40
DCCD	NCPDI-DISCHARGE CATEGORY CODE	character	4
DCNM	NCPID-DISCHARGE CATEGORY NAME	character	30
EPAINDCD	EPA-INDUSTRIAL CATEGORY CODE	character	2
EPAINDNM	EPA-INDUSTRIAL CATEGORY NAME	character	25
PIPE	PIPE DESCRIPTION	character	30
PIAC	PIPE INACTIVE CODE	character	1
FLOWANN	ANNUAL AVERAGE FLOW PIPE IN MG	numeric	8
FLOWFAL	FLOW PIPE FALL IN MG	numeric	8
FLOWSPR	FLOW PIPE SPRING IN MG	numeric	8
FLOWSUM	FLOW PIPE SUMMER IN MG	numeric	8
FLOWWIN	FLOW PIPE WINTER IN MG	numeric	8
FLOWPROC	ANNUAL AVERAGE OF PROCESS FLOW IN MG	numeric	8
FLOWFAL1	PROCESS FLOW PIPE FALL IN MG	numeric	8
FLOWSPR1	PROCESS FLOW PIPE SPRING IN MG	numeric	8
FLOWSUM1	PROCESS FLOW PIPE SUMMER IN MG	numeric	8
FLOWWIN1	PROCESS FLOW PIPE WINTER IN MG	numeric	8
FLOWPIPE	AVERAGE FLOW PIPE (TOTAL) IN MGD	numeric	8
FLOW4	FLOW FROM NEEDS (MGD)	numeric	8
FLOWBAS4	FLOW BASIS CODE FOR FLOW FROM NEEDS	character	2

FLOWBASE	POLL. BASIS CODE - DETAILED DESC. FLOW	character	3
FLOWTYPE	FLOW TYPE	character	1
FTBASE	FLOW TYPE BASIS CODE	character	1
BODANN	BIOCHEMICAL OXYGEN DEMAND ANNUAL IN LB	numeric	8
BODFAL	BOD FALL IN LB	numeric	8
BODSPR	BOD SPRING IN LB	numeric	8
BODSUM	BOD SUMMER IN LB	numeric	8
BODWIN	BOD WINTER IN LB	numeric	8
BODBASE	POLL. BASIS CODE - DETAILED DESC. BOD	character	3
TSSANN	TOTAL SUSPENDED SOLIDS ANNUAL IN LB	numeric	8
TSSFAL	TSS FALL IN LB	numeric	8
TSSSPR	TSS SPRING IN LB	numeric	8
TSSSUM	TSS SUMMER IN LB	numeric	8
TSSWIN	TSS WINTER IN LB	numeric	8
TSSBASE	POLL. BASIS CODE - DETAILED DESC. TSS	character	3
NANN	NITROGEN ANNUAL (TOTAL) IN LB	numeric	8
NFAL	NITROGEN FALL IN LB	numeric	8
NSPR	NITROGEN SPRING IN LB	numeric	8
NSUM	NITROGEN SUMMER IN LB	numeric	8
NWIN	NITROGEN WINTER IN LB	numeric	8
NBASE	POLL. BASIS CODE - DETAILED DESC. N	character	3
PANN	PHOSPHORUS ANNUAL (TOTAL) IN LB	numeric	8
PFAL	PHOSPHORUS FALL IN LB	numeric	8
PSPR	PHOSPHORUS SPRING IN LB	numeric	8
PSUM	PHOSPHORUS SUMMER IN LB	numeric	8
PWIN	PHOSPHORUS WINTER IN LB	numeric	8
PBASE	POLL. BASIS CODE - DETAILED DESC. P	character	3
ASANN	ARSENIC ANNUAL (TOTAL) IN LB	numeric	8
ASFAL	ARSENIC FALL IN LB	numeric	8
ASSPR	ARSENIC SPRING IN LB	numeric	8
ASSUM	ARSENIC SUMMER IN LB	numeric	8
ASWIN	ARSENIC WINTER IN LB	numeric	8

ASBASE	POLL. BASIS CODE - DETAILED DESC. AS	character	3
CDANN	CADMIUM ANNUAL (TOTAL) IN LB	numeric	8
CDFAL	CADMIUM FALL IN LB	numeric	8
CDSPR	CADMIUM SPRING IN LB	numeric	8
CDSUM	CADMIUM SUMMER IN LB	numeric	8
CDWIN	CADMIUM WINTER IN LB	numeric	8
CDBASE	POLL. BASIS CODE - DETAILED DESC. CD	character	3
CRANN	CHROMIUM ANNUAL (TOTAL) IN LB	numeric	8
CRFAL	CHROMIUM FALL IN LB	numeric	8
CRSPR	CHROMIUM SPRING IN LB	numeric	8
CRSUM	CHROMIUM SUMMER IN LB	numeric	8
CRWIN	CHROMIUM WINTER IN LB	numeric	8
CRBASE	POLL. BASIS CODE - DETAILED DESC. CR	character	3
CUANN	COPPER ANNUAL (TOTAL) IN LB	numeric	8
CUFAL	COPPER FALL IN LB	numeric	8
CUSPR	COPPER SPRING IN LB	numeric	8
CUSUM	COPPER SUMMER IN LB	numeric	8
CUWIN	COPPER WINTER IN LB	numeric	8
CUBASE	POLL. BASIS CODE - DETAILED DESC. CU	character	3
FEANN	IRON ANNUAL (TOTAL) IN LB	numeric	8
FEFAL	IRON FALL IN LB	numeric	8
FESPR	IRON SPRING IN LB	numeric	8
FESUM	IRON SUMMER IN LB	numeric	8
FEWIN	IRON WINTER IN LB	numeric	8
FEBASE	POLL. BASIS CODE - DETAILED DESC. FE	character	3
HGANN	MERCURY ANNUAL (TOTAL) IN LB	numeric	8
HGFAL	MERCURY FALL IN LB	numeric	8
HGSPR	MERCURY SPRING IN LB	numeric	8
HGSUM	MERCURY SUMMER IN LB	numeric	8
HGWIN	MERCURY WINTER IN LB	numeric	8
HGBASE	POLL. BASIS CODE - DETAILED DESC. HG	character	3
PBANN	LEAD ANNUAL (TOTAL) IN LB	numeric	8

PBFAL	LEAD FALL IN LB	numeric	8
PBSPR	LEAD SPRING IN LB	numeric	8
PBSUM	LEAD SUMMER IN LB	numeric	8
PBWIN	LEAD WINTER IN LB	numeric	8
PBBASE	POLL. BASIS CODE - DETAILED DESC. PB	character	3
ZNANN	ZINC ANNUAL (TOTAL) IN LB	numeric	8
ZNFAL	ZINC FALL IN LB	numeric	8
ZNSPR	ZINC SPRING IN LB	numeric	8
ZNSUM	ZINC SUMMER IN LB	numeric	8
ZNWIN	ZINC WINTER IN LB	numeric	8
ZNBASE	POLL. BASIS CODE - DETAILED DESC. ZN	character	3
OGANN	OIL AND GREASE ANNUAL (TOTAL) IN LB	numeric	8
OGFAL	OIL AND GREASE FALL IN LB	numeric	8
OGSPR	OIL AND GREASE SPRING IN LB	numeric	8
OGSUM	OIL AND GREASE SUMMER IN LB	numeric	8
OGWIN	OIL AND GREASE WINTER IN LB	numeric	8
OGBASE	POLL. BASIS CODE - DETAILED DESC. OIL	character	3
FCBANN	FECAL COLIFORM BACTERIA ANNUAL IN CELLS	numeric	8
FCBFAL	FCB FALL IN CELLS	numeric	8
FCBSPR	FCB SPRING IN CELLS	numeric	8
FCBSUM	FCB SUMMER IN CELLS	numeric	8
FCBWIN	FCB WINTER IN CELLS	numeric	8
FCBBASE	POLL. BASIS CODE - DETAILED DESC. FCB	character	3
PCBANN	POLICHLORINATED BYPHENYLS ANNUAL IN LB	numeric	8
PCBFAL	PCB FALL IN LB	numeric	8
PCBSPR	PCB SPRING IN LB	numeric	8
PCBSUM	PCB SUMMER IN LB	numeric	8
PCBWIN	PCB WINTER IN LB	numeric	8
PCBBASE	POLL. BASIS CODE - DETAILED DESC. PCB	character	3
CHPANN	CHLORINATED HYDROCARBONS ANNUAL IN LB	numeric	8
CHPFAL	CHLORINATED HYDROCARBONS FALL IN LB	numeric	8
CHPSPR	CHLORINATED HYDROCARBONS SPRING IN LB	numeric	8

CHPSUM	CHLORINATED HYDROCARBONS SUMMER IN LB	numeric	8
CHPWIN	CHLORINATED HYDROCARBONS WINTER IN LB	numeric	8
CHPBASE	POLL. BASIS CODE - DETAILED DESC. CHP	character	3
PFACTOR	PROCESS FACTOR	numeric	8
TRET	TREATMENT TYPES	character	24
WAST	TYPE OF EFFLUENT WASTE	character	2
PLAT	PIPE LATITUDE - DEGREES,MINUTES,SECONDS	character	8
PLAT1	PIPE LATITUDE - DECIMAL DEGREES	numeric	8
PLON	PIPE LONGITUDE - DEGREES,MINUTES,SECONDS	character	9
PLON1	PIPE LONGITUDE - DECIMAL DEGREES	numeric	8
PLLSORS	PIPE LATITUDE/LONGITUDE SOURCE CODE	character	1
FALCOEF	FALL COEFFICIENT	numeric	8
SPRCOEF	SPRING COEFFICIENT	numeric	8
SUMCOEF	SUMMER COEFFICIENT	numeric	8
WINCOEF	WINTER COEFFICIENT	numeric	8
TPCBOD	TYP. POLLUTANT CONC. FOR BOD (mg/L)	numeric	8
TPCBOD_S	TPC SOURCE CODE FOR BOD	character	1
TPCTSS	TYP. POLLUTANT CONC. FOR TSS (mg/L)	numeric	8
TPCTSS_S	TPC SOURCE CODE FOR TSS	character	1
TPCN	TYP. POLLUTANT CONC. FOR P (mg/L)	numeric	8
TPCN_S	TPC SOURCE CODE FOR P	character	1
TPCP	TYP. POLLUTANT CONC. FOR N (mg/L)	numeric	8
TPCP_S	TPC SOURCE CODE FOR N	character	1
TPCFCB	TYP. POLL. FOR FCB (cell/100mL)	numeric	8
TPCFCB_S	TPC SOURCE CODE FOR FCB	character	1
TPCAS	TYP. POLLUTANT CONC. FOR AS (mg/L)	numeric	8
TPCAS_S	TPC SOURCE CODE FOR AS	character	1
TPCCD	TYP. POLLUTANT CONC. FOR CD (mg/L)	numeric	8
TPCCD_S	TPC SOURCE CODE FOR CD	character	1
TPCCR	TYP. POLLUTANT CONC. FOR CR (mg/L)	numeric	8
TPCCR_S	TPC SOURCE CODE FOR CR	character	1
TPCCU	TYP. POLLUTANT CONC. FOR CU (mg/L)	numeric	8

TPCCU_S	TPC SOURCE CODE FOR CU	character	1
TPCFE	TYP. POLLUTANT CONC. FOR FE (mg/L)	numeric	8
TPCFE_S	TPC SOURCE CODE FOR FE	character	1
TPCPB	TYP. POLLUTANT CONC. FOR PB (mg/L)	numeric	8
TPCPB_S	TPC SOURCE CODE FOR PB	character	1
TPCHG	TYP. POLLUTANT CONC. FOR HG (mg/L)	numeric	8
TPCHG_S	TPC SOURCE CODE FOR HG	character	1
TPCZN	TYP. POLLUTANT CONC. FOR ZN (mg/L)	numeric	8
TPCZN_S	TPC SOURCE CODE FOR ZN	character	1
TPCOG	TYP. POLLUTANT CONC. FOR OG (mg/L)	numeric	8
TPCOG_S	TPC SOURCE CODE FOR OG	character	1
TPCPCB	TYP. POLLUTANT CONC. FOR PCB (mg/L)	numeric	8
TPCPCB_S	TPC SOURCE CODE FOR PCB	character	1
TPCCHP	TYP. POLLUTANT CONC. FOR CHP (mg/L)	numeric	8
TPCCHP_S	TPC SOURCE CODE FOR CHP	character	1
TPCSORS	TPC SOURCE CODE FOR ALL POLLUTANTS	character	1
SDAC	SPECIAL DISCHARGE ACTIVITY CODES	character	2
OPDAYS	OPERATING DAYS	numeric	8
OPDAYS_A	OPERATING DAYS - ADJUSTED	numeric	8
OPDSORS	OPERATING DAYS SOURCE CODE	character	1

Variables in Permit, DMR and TPC Loading File (G_FILE6.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
NPID	NPDES NUMBER	character	9
DSCH	DISCHARGE NO.	character	3
PDSG	LIMIT DISCHARGE NO./REPORT DESIGNATOR	character	4
MADI	MAJOR DISCHARGE INDICATOR	character	1
MLOC	MONITORING LOCATION	character	1
MDML	MINIMUM NO. OF DMR LINES	character	2
FNML	FACILITY NAME	character	30
SIC	SIC CODE - 1987 FACILITY DESC.	character	4
SICIG	SIC INDUSTRY GROUP CODE	character	3
SICMG	SIC MAJOR GROUP CODE	character	2
SICDG	SIC DIVISION CODE	character	1
SICNM	SIC NAME	character	40
DCCD	NCPDI-DISCHARGE CATEGORY CODE	character	4
DCNM	NCPDI-DISCHARGE CATEGORY NAME	character	30
EPAINDCD	EPA-INDUSTRIAL CLASSIFICATION CODE	character	2
EPAINDNM	EPA-INDUSTRIAL CLASSIFICATION NAME	character	25
PIPE	PIPE DESC.	character	30
PIAC	PIPE INACTIVE CODE	character	1
FLOWANN	ANNUAL AVERAGE FLOW PIPE IN MG	numeric	8
FLOWFAL	FLOW PIPE FALL IN MG	numeric	8
FLOWSPR	FLOW PIPE SPRING IN MG	numeric	8
FLOWSUM	FLOW PIPE SUMMER IN MG	numeric	8
FLOWWIN	FLOW PIPE WINTER IN MG	numeric	8
NUFLOFAL	FLOW PIPE FALL IN MG - NO. OF OBS.	numeric	8
NUFLOSPR	FLOW PIPE SPRING IN MG - NO. OF OBS.	numeric	8
NUFLOSUM	FLOW PIPE SUMMER IN MG - NO. OF OBS.	numeric	8
NUFLOWIN	FLOW PIPE WINTER IN MG - NO. OF OBS.	numeric	8
FLOWPROC	ANNUAL AVERAGE OF PROCESS FLOW IN MG	numeric	8
FLOWFAL1	PROCESS FLOW PIPE FALL IN MG	numeric	8

FLOWSPR1	PROCESS FLOW PIPE SPRING IN MG	numeric	8
FLOWSUM1	PROCESS FLOW PIPE SUMMER IN MG	numeric	8
FLOWWIN1	PROCESS FLOW PIPE WINTER IN MG	numeric	8
FLOWPIPE	AVERAGE FLOW PIPE (TOTAL) IN MGD	numeric	8
FLOWBASE	POLL. BASIS CODE - DETAILED DESC. (FLOW)	character	3
FLOWCODE	POLL. BASIS CODE - SHORT DESC. (FLOW)	character	1
FLOWTYPE	FLOW TYPE	character	1
FTBASE	FLOW TYPE BASIS CODE	character	1
BODANN	BIOCHEMICAL OXYGEN DEMAND ANNUAL IN LB	numeric	8
BODBASE	POLL. BASIS CODE - DETAILED DESC. (BOD)	character	3
BODCODE	POLL. BASIS CODE - SHORT DESC. (BOD)	character	1
BODFAL	BOD FALL IN LB	numeric	8
BODSPR	BOD SPRING IN LB	numeric	8
BODSUM	BOD SUMMER IN LB	numeric	8
BODWIN	BOD WINTER IN LB	numeric	8
NUBODFAL	BOD FALL IN LB - NO. OF OBS.	numeric	8
NUBODSPR	BOD SPRING IN LB - NO. OF OBS.	numeric	8
NUBODSUM	BOD SUMMER IN LB - NO. OF OBS.	numeric	8
NUBODWIN	BOD WINTER IN LB - NO. OF OBS.	numeric	8
TSSANN	TOTAL SUSPENDED SOLIDS ANNUAL IN LB	numeric	8
TSSBASE	POLL. BASIS CODE - DETAILED DESC. (TSS)	character	3
TSSCODE	POLL. BASIS CODE - SHORT DESC. (TSS)	character	1
TSSFAL	TSS FALL IN LB	numeric	8
TSSSPR	TSS SPRING IN LB	numeric	8
TSSSUM	TSS SUMMER IN LB	numeric	8
TSSWIN	TSS WINTER IN LB	numeric	8
NUTSSFAL	TSS FALL IN LB - NO. OF OBS.	numeric	8
NUTSSSPR	TSS SPRING IN LB - NO. OF OBS.	numeric	8
NUTSSSUM	TSS SUMMER IN LB - NO. OF OBS.	numeric	8
NUTSSWIN	TSS WINTER IN LB - NO. OF OBS.	numeric	8
NANN	NITROGEN ANNUAL (TOTAL) IN LB	numeric	8
NBASE	POLL. BASIS CODE - DETAILED DESC. (N)	character	3

NCODE	POLL. BASIS CODE - SHORT DESC. (N)	character	1
NFAL	NITROGEN FALL IN LB	numeric	8
NSPR	NITROGEN SPRING IN LB	numeric	8
NSUM	NITROGEN SUMMER IN LB	numeric	8
NWIN	NITROGEN WINTER IN LB	numeric	8
NUNFAL	NITROGEN FALL IN LB - NO. OF OBS.	numeric	8
NUNSPR	NITROGEN SPRING IN LB - NO. OF OBS.	numeric	8
NUNSUM	NITROGEN SUMMER IN LB - NO. OF OBS.	numeric	8
NUNWIN	NITROGEN WINTER IN LB - NO. OF OBS.	numeric	8
PANN	PHOSPHORUS ANNUAL (TOTAL) IN LB	numeric	8
PBASE	POLL. BASIS CODE - DETAILED DESC. (P)	character	3
PCODE	POLL. BASIS CODE - SHORT DESC. (P)	character	1
PFAL	PHOSPHORUS FALL IN LB	numeric	8
PSPR	PHOSPHORUS SPRING IN LB	numeric	8
PSUM	PHOSPHORUS SUMMER IN LB	numeric	8
PWIN	PHOSPHORUS WINTER IN LB	numeric	8
NUPFAL	PHOSPHORUS FALL IN LB - NO. OF OBS.	numeric	8
NUPSPR	PHOSPHORUS SPRING IN LB - NO. OF OBS.	numeric	8
NUPSUM	PHOSPHORUS SUMMER IN LB - NO. OF OBS.	numeric	8
NUPWIN	PHOSPHORUS WINTER IN LB - NO. OF OBS.	numeric	8
ASANN	ARSENIC ANNUAL (TOTAL) IN LB	numeric	8
ASBASE	POLL. BASIS CODE - DETAILED DESC. (AS)	character	3
ASCODE	POLL. BASIS CODE - SHORT DESC. (AS)	character	1
ASFAL	ARSENIC FALL IN LB	numeric	8
ASSPR	ARSENIC SPRING IN LB	numeric	8
ASSUM	ARSENIC SUMMER IN LB	numeric	8
ASWIN	ARSENIC WINTER IN LB	numeric	8
NUASFAL	ARSENIC FALL IN LB - NO. OF OBS.	numeric	8
NUASSPR	ARSENIC SPRING IN LB - NO. OF OBS.	numeric	8
NUASSUM	ARSENIC SUMMER IN LB - NO. OF OBS.	numeric	8
NUASWIN	ARSENIC WINTER IN LB - NO. OF OBS.	numeric	8
CDANN	CADMIUM ANNUAL (TOTAL) IN LB	numeric	8

CDBASE	POLL. BASIS CODE - DETAILED DESC. (CD)	character	3
CDCODE	POLL. BASIS CODE - SHORT DESC. (CD)	character	1
CDFAL	CADMIUM FALL IN LB	numeric	8
CDSPR	CADMIUM SPRING IN LB	numeric	8
CDSUM	CADMIUM SUMMER IN LB	numeric	8
CDWIN	CADMIUM WINTER IN LB	numeric	8
NUCDFAL	CADMIUM FALL IN LB - NO. OF OBS.	numeric	8
NUCDSPR	CADMIUM SPRING IN LB - NO. OF OBS.	numeric	8
NUCDSUM	CADMIUM SUMMER IN LB - NO. OF OBS.	numeric	8
NUCDWIN	CADMIUM WINTER IN LB - NO. OF OBS.	numeric	8
CRANN	CHROMIUM ANNUAL (TOTAL) IN LB	numeric	8
CRBASE	POLL. BASIS CODE - DETAILED DESC. (CR)	character	3
CRCODE	POLL. BASIS CODE - SHORT DESC. (CR)	character	1
CRFAL	CHROMIUM FALL IN LB	numeric	8
CRSPR	CHROMIUM SPRING IN LB	numeric	8
CRSUM	CHROMIUM SUMMER IN LB	numeric	8
CRWIN	CHROMIUM WINTER IN LB	numeric	8
NUCRFAL	CHROMIUM FALL IN LB - NO. OF OBS.	numeric	8
NUCRSPR	CHROMIUM SPRING IN LB - NO. OF OBS.	numeric	8
NUCRSUM	CHROMIUM SUMMER IN LB - NO. OF OBS.	numeric	8
NUCRWIN	CHROMIUM WINTER IN LB - NO. OF OBS.	numeric	8
CUANN	COPPER ANNUAL (TOTAL) IN LB	numeric	8
CUBASE	POLL. BASIS CODE - DETAILED DESC. (CU)	character	3
CUCODE	POLL. BASIS CODE - SHORT DESC. (CU)	character	1
CUFAL	COPPER FALL IN LB	numeric	8
CUSPR	COPPER SPRING IN LB	numeric	8
CUSUM	COPPER SUMMER IN LB	numeric	8
CUWIN	COPPER WINTER IN LB	numeric	8
NUCUFAL	COPPER FALL IN LB - NO. OF OBS.	numeric	8
NUCUSPR	COPPER SPRING IN LB - NO. OF OBS.	numeric	8
NUCUSUM	COPPER SUMMER IN LB - NO. OF OBS.	numeric	8
NUCUWIN	COPPER WINTER IN LB - NO. OF OBS.	numeric	8

FEANN	IRON ANNUAL (TOTAL) IN LB	numeric	8
FEBASE	POLL. BASIS CODE - DETAILED DESC. (FE)	character	3
FECODE	POLL. BASIS CODE - SHORT DESC. (FE)	character	1
FEFAL	IRON FALL IN LB	numeric	8
FESPR	IRON SPRING IN LB	numeric	8
FESUM	IRON SUMMER IN LB	numeric	8
FEWIN	IRON WINTER IN LB	numeric	8
NUFEFAL	IRON FALL IN LB - NO. OF OBS.	numeric	8
NUFESPR	IRON SPRING IN LB - NO. OF OBS.	numeric	8
NUFESUM	IRON SUMMER IN LB - NO. OF OBS.	numeric	8
NUFEWIN	IRON WINTER IN LB - NO. OF OBS.	numeric	8
HGANN	MERCURY ANNUAL (TOTAL) IN LB	numeric	8
HGBASE	POLL. BASIS CODE - DETAILED DESC. (HG)	character	3
HGCODE	POLL. BASIS CODE - SHORT DESC. (HG)	character	1
HGFAL	MERCURY FALL IN LB	numeric	8
HGSPR	MERCURY SPRING IN LB	numeric	8
HGSUM	MERCURY SUMMER IN LB	numeric	8
HGWIN	MERCURY WINTER IN LB	numeric	8
NUHGFAL	MERCURY FALL IN LB - NO. OF OBS.	numeric	8
NUHGSPR	MERCURY SPRING IN LB - NO. OF OBS.	numeric	8
NUHGSUM	MERCURY SUMMER IN LB - NO. OF OBS.	numeric	8
NUHGWIN	MERCURY WINTER IN LB - NO. OF OBS.	numeric	8
PBANN	LEAD ANNUAL (TOTAL) IN LB	numeric	8
PBBASE	POLL. BASIS CODE - DETAILED DESC. (PB)	character	3
PBCODE	POLL. BASIS CODE - SHORT DESC. (PB)	character	1
PBFAL	LEAD FALL IN LB	numeric	8
PBSPR	LEAD SPRING IN LB	numeric	8
PBSUM	LEAD SUMMER IN LB	numeric	8
PBWIN	LEAD WINTER IN LB	numeric	8
NUPBFAL	LEAD FALL IN LB - NO. OF OBS.	numeric	8
NUPBSPR	LEAD SPRING IN LB - NO. OF OBS.	numeric	8
NUPBSUM	LEAD SUMMER IN LB - NO. OF OBS.	numeric	8

NUPBWIN	LEAD WINTER IN LB - NO. OF OBS.	numeric	8
ZNANN	ZINC ANNUAL (TOTAL) IN LB	numeric	8
ZNBASE	POLL. BASIS CODE - DETAILED DESC. (ZN)	character	3
ZNCODE	POLL. BASIS CODE - SHORT DESC. (ZN)	character	1
ZNFAL	ZINC FALL IN LB	numeric	8
ZNSPR	ZINC SPRING IN LB	numeric	8
ZNSUM	ZINC SUMMER IN LB	numeric	8
ZNWIN	ZINC WINTER IN LB	numeric	8
NUZNFAL	ZINC FALL IN LB - NO. OF OBS.	numeric	8
NUZNSPR	ZINC SPRING IN LB - NO. OF OBS.	numeric	8
NUZNSUM	ZINC SUMMER IN LB - NO. OF OBS.	numeric	8
NUZNWIN	ZINC WINTER IN LB - NO. OF OBS.	numeric	8
FCBANN	FECAL COLIFORM BACTERIA ANNUAL IN CELLS	numeric	8
FCBBASE	POLL. BASIS CODE - DETAILED DESC. (FCB)	character	3
FCBCODE	POLL. BASIS CODE - SHORT DESC. (FCB)	character	1
FCBFAL	FCB FALL IN CELLS/DAY	numeric	8
FCBSPR	FCB SPRING IN CELLS	numeric	8
FCBSUM	FCB SUMMER IN CELLS	numeric	8
FCBWIN	FCB WINTER IN CELLS	numeric	8
NUFCBFAL	FCB FALL IN CELLS/DAY - NO. OF OBS.	numeric	8
NUFCBSPR	FCB SPRING IN CELLS - NO. OF OBS.	numeric	8
NUFCBSUM	FCB SUMMER IN CELLS - NO. OF OBS.	numeric	8
NUFCBWIN	FCB WINTER IN CELLS - NO. OF OBS.	numeric	8
OGANN	OIL AND GAS ANNUAL (TOTAL) IN LB	numeric	8
OGBASE	POLL. BASIS CODE - DETAILED DESC. (OG)	character	3
OGCODE	POLL. BASIS CODE - SHORT DESC. (OG)	character	1
OGFAL	OIL AND GREASE FALL IN LB	numeric	8
OGSPR	OIL AND GREASE SPRING IN LB	numeric	8
OGSUM	OIL AND GREASE SUMMER IN LB	numeric	8
OGWIN	OIL AND GREASE WINTER IN LB	numeric	8
NUOGFAL	OIL AND GREASE FALL IN LB - NO. OBS.	numeric	8
NUOGSPR	OIL AND GREASE SPRING IN LB - NO. OBS.	numeric	8

NUOGSUM	OIL AND GREASE SUMMER IN LB - NO. OBS.	numeric	8
NUOGWIN	OIL AND GREASE WINTER IN LB - NO. OBS.	numeric	8
PFACTOR	P-FACTOR	numeric	8
PLAT	PIPE LATITUDE - DEGREES,MINUETS,SECONDS	character	8
PLAT1	PIPE LATITUDE - DECIMAL DEGREES	numeric	8
PLON	PIPE LONGITUDE - DEGREES,MINUETS,SECONDS	character	9
PLON1	PIPE LONGITUDE - DECIMAL DEGREES	numeric	8
PLLSORS	PIPE LATITUDE/LONGITUDE SOURCE CODE	character	1
FALCOEF	FALL COEFFICIENT	numeric	8
SPRCOEF	SPRING COEFFICIENT	numeric	8
SUMCOEF	SUMMER COEFFICIENT	numeric	8
WINCOEF	WINTER COEFFICIENT	numeric	8
TPCBOD	TYP. POLLUTANT CONC. FOR BOD (mg/L)	numeric	8
TPCTSS	TYP. POLLUTANT CONC. FOR TSS (mg/L)	numeric	8
TPCN	TYP. POLLUTANT CONC. FOR N (mg/L)	numeric	8
TPCP	TYP. POLLUTANT CONC. FOR P (mg/L)	numeric	8
TPCAS	TYP. POLLUTANT CONC. FOR AS (mg/L)	numeric	8
TPCCD	TYP. POLLUTANT CONC. FOR CD (mg/L)	numeric	8
TPCCR	TYP. POLLUTANT CONC. FOR CR (mg/L)	numeric	8
TPCCU	TYP. POLLUTANT CONC. FOR CU (mg/L)	numeric	8
TPCFE	TYP. POLLUTANT CONC. FOR FE (mg/L)	numeric	8
TPCHG	TYP. POLLUTANT CONC. FOR HG (mg/L)	numeric	8
TPCPB	TYP. POLLUTANT CONC. FOR PB (mg/L)	numeric	8
TPCZN	TYP. POLLUTANT CONC. FOR ZN (mg/L)	numeric	8
TPCOG	TYP. POLLUTANT CONC. FOR OG (mg/L)	numeric	8
TPCFCB	TYP. POLLUTANT CONC. FOR FCB (c/100mL)	numeric	8
TPCBOD_S	TPC SOURCE CODE FOR BOD	character	1
TPCTSS_S	TPC SOURCE CODE FOR TSS	character	1
TPCN_S	TPC SOURCE CODE FOR N	character	1
TPCP_S	TPC SOURCE CODE FOR P	character	1
TPCAS_S	TPC SOURCE CODE FOR AS	character	1
TPCCD_S	TPC SOURCE CODE FOR CD	character	1

TPCCR_S	TPC SOURCE CODE FOR CR	character	1
TPCCU_S	TPC SOURCE CODE FOR CU	character	1
TPCFE_S	TPC SOURCE CODE FOR FE	character	1
TPCHG_S	TPC SOURCE CODE FOR HG	character	1
TPCPB_S	TPC SOURCE CODE FOR PB	character	1
TPCZN_S	TPC SOURCE CODE FOR ZN	character	1
TPCOG_S	TPC SOURCE CODE FOR OG	character	1
TPCFCB_S	TPC SOURCE CODE FOR FCB	character	1
TPCSORS	TPC SOURCE CODE ALL POLLUTANTS	character	1
TRET	TREATMENT TYPES	character	24
WAST	TYPE OF EFFLUENT WAST FROM A PIPE	character	2
SDAC	SPECIAL DISCHARGE ACTIVITY CODE	character	2
OPDAYS	OPERATING DAYS	numeric	8
OPDAYS_A	OPERATING DAYS - ADJUSTED	numeric	8
OPDSORS	OPERATING DAYS SOURCE CODE	character	1
PO00605A	N2 ORGANIC ANNUAL (LBS/DAY)	numeric	8
BAS00605	POLL. BASIS CODE - DETAILED DESC. (ORGANIC)	character	3
ORGCODE	POLL. BASIS CODE - SHORT DESC. (ORGANIC)	character	1
PO00605F	N2 ORGANIC FALL (LBS/DAY)	numeric	8
PO00605S	N2 ORGANIC SPRING (LBS/DAY)	numeric	8
PO00605H	N2 ORGANIC SUMMER (LBS/DAY)	numeric	8
PO00605W	N2 ORGANIC WINTER (LBS/DAY)	numeric	8
NU00605F	N2 ORGANIC # OF OBSERVATIONS IN FALL	numeric	8
NU00605S	N2 ORGANIC # OF OBSERVATIONS IN SPRING	numeric	8
NU00605H	N2 ORGANIC # OF OBSERVATIONS IN SUMMER	numeric	8
NU00605W	N2 ORGANIC # OF OBSERVATIONS IN WINTER	numeric	8
PO00610A	N2 AMMONIA ANNUAL (LBS/DAY)	numeric	8
BAS00610	POLL. BASIS CODE - DETAILED DESC. (AMMONIA)	character	3
AMMCODE	POLL. BASIS CODE - SHORT DESC. (AMMONIA)	character	1
PO00610F	N2 AMMONIA FALL (LBS/DAY)	numeric	8
PO00610S	N2 AMMONIA SPRING (LBS/DAY)	numeric	8
PO00610H	N2 AMMONIA SUMMER (LBS/DAY)	numeric	8

PO00610W	N2 AMMONIA WINTER (LBS/DAY)	numeric	8
NU00610F	N2 AMMONIA # OF OBSERVATIONS IN FALL	numeric	8
NU00610S	N2 AMMONIA # OF OBSERVATIONS IN SPRING	numeric	8
NU00610H	N2 AMMONIA # OF OBSERVATIONS IN SUMMER	numeric	8
NU00610W	N2 AMMONIA # OF OBSERVATIONS IN WINTER	numeric	8
PO00615A	N2 NITRITE ANNUAL (LBS/DAY)	numeric	8
BAS00615	POLL. BASIS CODE - DETAILED DESC. (NITRITE)	character	3
NO2CODE	POLL. BASIS CODE - SHORT DESC. (NITRITE)	character	1
PO00615F	N2 NITRITE FALL (LBS/DAY)	numeric	8
PO00615S	N2 NITRITE SPRING (LBS/DAY)	numeric	8
PO00615H	N2 NITRITE SUMMER (LBS/DAY)	numeric	8
PO00615W	N2 NITRITE WINTER (LBS/DAY)	numeric	8
NU00615F	N2 NITRITE # OF OBSERVATIONS IN FALL	numeric	8
NU00615S	N2 NITRITE # OF OBSERVATIONS IN SPRING	numeric	8
NU00615H	N2 NITRITE # OF OBSERVATIONS IN SUMMER	numeric	8
NU00615W	N2 NITRITE # OF OBSERVATIONS IN WINTER	numeric	8
PO00620A	N2 NITRATE ANNUAL (LBS/DAY)	numeric	8
BAS00620	POLL. BASIS CODE - DETAILED DESC. (NITRATE)	character	3
NO3CODE	POLL. BASIS CODE - SHORT DESC. (NITRATE)	character	1
PO00620F	N2 NITRATE FALL (LBS/DAY)	numeric	8
PO00620S	N2 NITRATE SPRING (LBS/DAY)	numeric	8
PO00620H	N2 NITRATE SUMMER (LBS/DAYS)	numeric	8
PO00620W	N2 NITRATE WINTER (LBS/DAY)	numeric	8
NU00620F	N2 NITRATE # OF OBSERVATIONS IN FALL	numeric	8
NU00620S	N2 NITRATE # OF OBSERVATIONS IN SPRING	numeric	8
NU00620H	N2 NITRATE # OF OBSERVATIONS IN SUMMER	numeric	8
NU00620W	N2 NITRATE # OF OBSERVATIONS IN WINTER	numeric	8
PO00625A	N2 KJELDAHL ANNUAL (LBS/DAY)	numeric	8
BAS00625	POLL. BASIS CODE - DETAILED DESC. (KJELDAHL)	character	3
KJECODE	POLL. BASIS CODE - SHORT DESC. (KJELDAHL)	character	1
PO00625F	N2 KJELDAHL FALL (LBS/DAY)	numeric	8
PO00625S	N2 KJELDAHL SPRING (LBS/DAY)	numeric	8

PO00625H	N2 KJELDAHL SUMMER (LBS/DAYS)	numeric	8
PO00625W	N2 KJELDAHL WINTER (LBS/DAY)	numeric	8
NU00625F	N2 KJELDAHL # OF OBSERVATIONS IN FALL	numeric	8
NU00625S	N2 KJELDAHL # OF OBSERVATIONS IN SPRING	numeric	8
NU00625H	N2 KJELDAHL # OF OBSERVATIONS IN SUMMER	numeric	8
NU00625W	N2 KJELDAHL # OF OBSERVATIONS IN WINTER	numeric	8
PO00640A	N2 INORGANIC ANNUAL (LBS/DAY)	numeric	8
BAS00640	POLL. BASIS CODE - DETAILED DESC. (INORGANIC)	character	3
INOCODE	POLL. BASIS CODE - SHORT DESC. (INORGANIC)	character	1
PO00640F	N2 INORGANIC FALL (LBS/DAY)	numeric	8
PO00640S	N2 INORGANIC SPRING (LBS/DAY)	numeric	8
PO00640H	N2 INORGANIC SUMMER (LBS/DAYS)	numeric	8
PO00640W	N2 INORGANIC WINTER (LBS/DAY)	numeric	8
NU00640F	N2 INORGANIC # OF OBSERVATIONS IN FALL	numeric	8
NU00640S	N2 INORGANIC # OF OBSERVATIONS IN SPRING	numeric	8
NU00640H	N2 INORGANIC # OF OBSERVATIONS IN SUMMER	numeric	8
NU00640W	N2 INORGANIC # OF OBSERVATIONS IN WINTER	numeric	8

Variables in Permit, DMR, and TPC Loading File (Facility Level) (G_FILE7.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
NPID	NPDES NUMBER	character	9
FACILNM	STANDARDIZED FACILITY NAME	character	40
NUMPIPES	TOTAL NUMBER OF PIPES	numeric	8
MADI	MAJOR DISCHARGE INDICATOR	character	1
SIC	SIC CODE - 1987 FACILITY DESCRIPTION	character	4
SICMG	SIC MAJOR GROUP CODE	character	2
SICIG	SIC INDUSTRY GROUP CODE	character	3
SICDG	SIC DIVISION CODE	character	1
SICNM	SIC NAME	character	40
DCCD	NCPDI-DISCHARGE CATEGORY CODE	character	4
DCNM	NCPDI-DISCHARGE CATEGORY NAME	character	30
EPAINDCD	EPA-INDUSTRIAL CLASSIFICATION CODE	character	2
EPAINDNM	EPA-INDUSTRIAL CLASSIFICATION NAME	character	25
PS	POINT SOURCE CATEGORY	character	1
SDAC	SPECIAL DISCHARGE ACTIVITY CODES	character	2
STTE	STATE CODE	character	2
FIPS	FEDERAL INFORMATION PROC. SYSTEM CODE	character	5
FLAT	FAC. LATITUDE-DEGREES,MINUETS,SECONDS	character	6
FLAT1	FAC. LATITUDE-DECIMAL DEGREES	numeric	8
FLON	FAC. LONGITUDE-DEGREES,MINUETS,SECONDS	character	7
FLON1	FAC. LONGITUDE-DECIMAL DEGREES	numeric	8
FLLSORS	FAC. LATITUDE/LONGITUDE SOURCE CODE	character	1
FCU	FAC. HYDROLOGIC CAT. UNIT CODE	character	8
FCUSORS	FAC. HYDROLOGIC CAT. UNIT SOURCE CODE	character	1
EDACODE	ESTUARINE/COASTAL DRAINAGE AREA CODE	character	5
EDASORS	EST./COASTAL DRAINAGE AREA SOURCE CODE	character	4
EDANAME	EDA/CDA Name	character	60
FLOWANN	ANNUAL AVERAGE FLOW PIPE IN MG	numeric	8

FLOWFAL	FLOW PIPE FALL IN MG	numeric	8
FLOWSPR	FLOW PIPE SPRING IN MG	numeric	8
FLOWSUM	FLOW PIPE SUMMER IN MG	numeric	8
FLOWWIN	FLOW PIPE WINTER IN MG	numeric	8
FLOWPROC	ANNUAL AVERAGE OF PROCESS FLOW IN MG	numeric	8
FLOWFAL1	PROCESS FLOW PIPE FALL IN MG	numeric	8
FLOWSPR1	PROCESS FLOW PIPE SPRING IN MG	numeric	8
FLOWSUM1	PROCESS FLOW PIPE SUMMER IN MG	numeric	8
FLOWWIN1	PROCESS FLOW PIPE WINTER IN MG	numeric	8
FLOWPIPE	AVERAGE FLOW PIPE (TOTAL) IN MGD	numeric	8
FLOW	AVERAGE DESIGN FLOW IN MGD	character	5
FLOWCODE	POLL. BASIS CODE - SHORT DESC. FLOW	character	1
BODANN	BIOCHEMICAL OXYGEN DEMAND ANNUAL IN LB	numeric	8
BODFAL	BOD FALL IN LB	numeric	8
BODSPR	BOD SPRING IN LB	numeric	8
BODSUM	BOD SUMMER IN LB	numeric	8
BODWIN	BOD WINTER IN LB	numeric	8
BODCODE	POLL. BASIS CODE - SHORT DESC. BOD	character	1
TSSANN	TOTAL SUSPENDED SOLIDS ANNUAL IN LB	numeric	8
TSSFAL	TSS FALL IN LB	numeric	8
TSSSPR	TSS SPRING IN LB	numeric	8
TSSSUM	TSS SUMMER IN LB	numeric	8
TSSWIN	TSS WINTER IN LB	numeric	8
TSSCODE	POLL. BASIS CODE - SHORT DESC. TSS	character	1
NANN	NITROGEN ANNUAL (TOTAL) IN LB	numeric	8
NFAL	NITROGEN FALL IN LB	numeric	8
NSPR	NITROGEN SPRING IN LB	numeric	8
NSUM	NITROGEN SUMMER IN LB	numeric	8
NWIN	NITROGEN WINTER IN LB	numeric	8
NCODE	POLL. BASIS CODE - SHORT DESC. N	character	1
PANN	PHOSPHORUS ANNUAL (TOTAL) IN LB	numeric	8
PFAL	PHOSPHORUS FALL IN LB	numeric	8

PSPR	PHOSPHORUS SPRING IN LB	numeric	8
PSUM	PHOSPHORUS SUMMER IN LB	numeric	8
PWIN	PHOSPHORUS WINTER IN LB	numeric	8
PCODE	POLL. BASIS CODE - SHORT DESC. P	character	1
ASANN	ARSENIC ANNUAL (TOTAL) IN LB	numeric	8
ASFAL	ARSENIC FALL IN LB	numeric	8
ASSPR	ARSENIC SPRING IN LB	numeric	8
ASSUM	ARSENIC SUMMER IN LB	numeric	8
ASWIN	ARSENIC WINTER IN LB	numeric	8
ASCODE	POLL. BASIS CODE - SHORT DESC. AS	character	1
CDANN	CADMIUM ANNUAL (TOTAL) IN LB	numeric	8
CDFAL	CADMIUM FALL IN LB	numeric	8
CDSPR	CADMIUM SPRING IN LB	numeric	8
CDSUM	CADMIUM SUMMER IN LB	numeric	8
CDWIN	CADMIUM WINTER IN LB	numeric	8
CDCODE	POLL. BASIS CODE - SHORT DESC. CD	character	1
CRANN	CHROMIUM ANNUAL (TOTAL) IN LB	numeric	8
CRFAL	CHROMIUM FALL IN LB	numeric	8
CRSPR	CHROMIUM SPRING IN LB	numeric	8
CRSUM	CHROMIUM SUMMER IN LB	numeric	8
CRWIN	CHROMIUM WINTER IN LB	numeric	8
CRCODE	POLL. BASIS CODE - SHORT DESC. CR	character	1
CUANN	COPPER ANNUAL (TOTAL) IN LB	numeric	8
CUFAL	COPPER FALL IN LB	numeric	8
CUSPR	COPPER SPRING IN LB	numeric	8
CUSUM	COPPER SUMMER IN LB	numeric	8
CUWIN	COPPER WINTER IN LB	numeric	8
CUCODE	POLL. BASIS CODE - SHORT DESC. CU	character	1
FEANN	IRON ANNUAL (TOTAL) IN LB	numeric	8
FEFAL	IRON FALL IN LB	numeric	8
FESPR	IRON SPRING IN LB	numeric	8
FESUM	IRON SUMMER IN LB	numeric	8

FEWIN	IRON WINTER IN LB	numeric	8
FECODE	POLL. BASIS CODE - SHORT DESC. FE	character	1
HGANN	MERCURY ANNUAL (TOTAL) IN LB	numeric	8
HGFAL	MERCURY FALL IN LB	numeric	8
HGSPR	MERCURY SPRING IN LB	numeric	8
HGSUM	MERCURY SUMMER IN LB	numeric	8
HGWIN	MERCURY WINTER IN LB	numeric	8
HGCODE	POLL. BASIS CODE - SHORT DESC. HG	character	1
PBANN	LEAD ANNUAL (TOTAL) IN LB	numeric	8
PBFAL	LEAD FALL IN LB	numeric	8
PBSPR	LEAD SPRING IN LB	numeric	8
PBSUM	LEAD SUMMER IN LB	numeric	8
PBWIN	LEAD WINTER IN LB	numeric	8
PBCODE	POLL. BASIS CODE - SHORT DESC. PB	character	1
ZNANN	ZINC ANNUAL (TOTAL) IN LB	numeric	8
ZNFAL	ZINC FALL IN LB	numeric	8
ZNSPR	ZINC SPRING IN LB	numeric	8
ZNSUM	ZINC SUMMER IN LB	numeric	8
ZNWIN	ZINC WINTER IN LB	numeric	8
ZNCODE	POLL. BASIS CODE - SHORT DESC. ZN	character	1
OGANN	OIL AND GREASE ANNUAL (TOTAL) IN LB	numeric	8
OGFAL	OIL AND GREASE FALL IN LB	numeric	8
OGSPR	OIL AND GREASE SPRING IN LB	numeric	8
OGSUM	OIL AND GREASE SUMMER IN LB	numeric	8
OGWIN	OIL AND GREASE WINTER IN LB	numeric	8
OGCODE	POLL. BASIS CODE - SHORT DESC. OIL	character	1
FCBANN	FECAL COLIFORM BACTERIA ANNUAL IN CELLS	numeric	8
FCBFAL	FCB FALL IN CELLS	numeric	8
FCBSPR	FCB SPRING IN CELLS	numeric	8
FCBSUM	FCB SUMMER IN CELLS	numeric	8
FCBWIN	FCB WINTER IN CELLS	numeric	8
FCBCODE	POLL. BASIS CODE - SHORT DESC. FCB	character	1

ORGANN	ORGANIC ANNUAL IN LB	numeric	8
ORGCODE	POLL. BASIS CODE - SHORT DESC. ORG	character	1
AMMANN	AMMONIA ANNUAL IN LB	numeric	8
AMMCODE	POLL. BASIS CODE - SHORT DESC. AMM	character	1
NO2ANN	NITRITE ANNUAL IN LB	numeric	8
NO2CODE	POLL. BASIS CODE - SHORT DESC. NO2	character	1
NO3ANN	NITRATE ANNUAL IN LB	numeric	8
NO3CODE	POLL. BASIS CODE - SHORT DESC. NO3	character	1
KJEANN	KJELDHAL ANNUAL IN LB	numeric	8
KJECODE	POLL. BASIS CODE - SHORT DESC. KJE	character	1
INOANN	INORGANIC ANNUAL IN LB	numeric	8
INOCODE	POLL. BASIS CODE - SHORT DESC. INO	character	1
REGION	REGION CODE	character	1
UNIQUE	UNIQUE CODE IN THE CAF	numeric	8

Variables in Pollutant Loads by Major Watershed File (EDA.TXT)

VARIABLE	LABEL	TYPE	LENGTH
EDACODE	ESTUARINE/COASTAL DRAINAGE AREA CODE	character	5
EDANAME	ESTUARINE/COASTAL DRAINAGE AREA NAME	character	60
MADI	MAJOR DISCHARGE INDICATOR	character	1
NO_FACIL	NUMBER OF FACILITIES	numeric	8
FLOWPROC	ANNUAL AVERAGE OF PROCESS FLOW IN MG	numeric	8
BODANN	BIOCHEMICAL OXYGEN DEMAND ANNUAL IN LB	numeric	8
TSSANN	TOTAL SUSPENDED SOLIDS ANNUAL IN LB	numeric	8
NANN	NITROGEN ANNUAL (TOTAL) IN LB	numeric	8
PANN	PHOSPHORUS ANNUAL (TOTAL) IN LB	numeric	8
ASANN	ARSENIC ANNUAL (TOTAL) IN LB	numeric	8
CDANN	CADMIUM ANNUAL (TOTAL) IN LB	numeric	8
CRANN	CHROMIUM ANNUAL (TOTAL) IN LB	numeric	8
CUANN	COPPER ANNUAL (TOTAL) IN LB	numeric	8
FEANN	IRON ANNUAL (TOTAL) IN LB	numeric	8
HGANN	MERCURY ANNUAL (TOTAL) IN LB	numeric	8
PBANN	LEAD ANNUAL (TOTAL) IN LB	numeric	8
ZNANN	ZINC ANNUAL (TOTAL) IN LB	numeric	8
OGANN	OIL AND GREASE ANNUAL (TOTAL) IN LB	numeric	8
FCBANN	FECAL COLIFORM BACTERIA ANNUAL IN CELLS	numeric	8

Variables in Pollutant Loads by Hydrologic Cataloging Unit File (HUC.TXT)

VARIABLE	LABEL	TYPE	LENGTH
FCU	FAC. HYDROLOGIC CAT. UNIT CODE	character	8
MADI	MAJOR DISCHARGE INDICATOR	character	1
NO_FACIL	NUMBER OF FACILITIES	numeric	8
FLOWPROC	ANNUAL AVERAGE OF PROCESS FLOW IN MG	numeric	8
BODANN	BIOCHEMICAL OXYGEN DEMAND ANNUAL IN LB	numeric	8
TSSANN	TOTAL SUSPENDED SOLIDS ANNUAL IN LB	numeric	8
NANN	NITROGEN ANNUAL (TOTAL) IN LB	numeric	8
PANN	PHOSPHORUS ANNUAL (TOTAL) IN LB	numeric	8
ASANN	ARSENIC ANNUAL (TOTAL) IN LB	numeric	8
CDANN	CADMIUM ANNUAL (TOTAL) IN LB	numeric	8
CRANN	CHROMIUM ANNUAL (TOTAL) IN LB	numeric	8
CUANN	COPPER ANNUAL (TOTAL) IN LB	numeric	8
FEANN	IRON ANNUAL (TOTAL) IN LB	numeric	8
HGANN	MERCURY ANNUAL (TOTAL) IN LB	numeric	8
PBANN	LEAD ANNUAL (TOTAL) IN LB	numeric	8
ZNANN	ZINC ANNUAL (TOTAL) IN LB	numeric	8
OGANN	OIL AND GREASE ANNUAL (TOTAL) IN LB	numeric	8
FCBANN	FECAL COLIFORM BACTERIA ANNUAL IN CELLS	numeric	8

Variables in Pollutant Loads by Unique File (UNIQ.TXT)

VARIABLE	LABEL	TYPE	LENGTH
UNIQUE	UNIQUE CODE FROM CAF	numeric	8
MADI	MAJOR DISCHARGE INDICATOR	character	1
NO_FACIL	NUMBER OF FACILITES	numeric	8
FLOWPROC	ANNUAL AVERAGE OF PROCESS FLOW IN MG	numeric	8
BODANN	BIOCHEMICAL OXYGEN DEMAND ANNUAL IN LB	numeric	8
TSSANN	TOTAL SUSPENDED SOLIDS ANNUAL IN LB	numeric	8
NANN	NITROGEN ANNUAL (TOTAL) IN LB	numeric	8
PANN	PHOSPHORUS ANNUAL (TOTAL) IN LB	numeric	8
ASANN	ARSENIC ANNUAL (TOTAL) IN LB	numeric	8
CDANN	CADMIUM ANNUAL (TOTAL) IN LB	numeric	8
CRANN	CHROMIUM ANNUAL (TOTAL) IN LB	numeric	8
CUANN	COPPER ANNUAL (TOTAL) IN LB	numeric	8
FEANN	IRON ANNUAL (TOTAL) IN LB	numeric	8
HGANN	MERCURY ANNUAL (TOTAL) IN LB	numeric	8
PBANN	LEAD ANNUAL (TOTAL) IN LB	numeric	8
ZNANN	ZINC ANNUAL (TOTAL) IN LB	numeric	8
OGANN	OIL AND GREASE ANNUAL (TOTAL) IN LB	numeric	8
FCBANN	FECAL COLIFORM BACTERIA ANNUAL IN CELLS	numeric	8

Variables in Pollutant Loads by State File (STATE.TXT)

VARIABLE	LABEL	TYPE	LENGTH
STTE	STATE CODE	character	2
MADI	MAJOR DISCHARGE INDICATOR	character	1
NO_FACIL	NUMBER OF FACILITES	numeric	8
FLOWPROC	ANNUAL AVERAGE OF PROCESS FLOW IN MG	numeric	8
BODANN	BIOCHEMICAL OXYGEN DEMAND ANNUAL IN LB	numeric	8
TSSANN	TOTAL SUSPENDED SOLIDS ANNUAL IN LB	numeric	8
NANN	NITROGEN ANNUAL (TOTAL) IN LB	numeric	8
PANN	PHOSPHORUS ANNUAL (TOTAL) IN LB	numeric	8
ASANN	ARSENIC ANNUAL (TOTAL) IN LB	numeric	8
CDANN	CADMIUM ANNUAL (TOTAL) IN LB	numeric	8
CRANN	CHROMIUM ANNUAL (TOTAL) IN LB	numeric	8
CUANN	COPPER ANNUAL (TOTAL) IN LB	numeric	8
FEANN	IRON ANNUAL (TOTAL) IN LB	numeric	8
HGANN	MERCURY ANNUAL (TOTAL) IN LB	numeric	8
PBANN	LEAD ANNUAL (TOTAL) IN LB	numeric	8
ZNANN	ZINC ANNUAL (TOTAL) IN LB	numeric	8
OGANN	OIL AND GREASE ANNUAL (TOTAL) IN LB	numeric	8
FCBANN	FECAL COLIFORM BACTERIA ANNUAL IN CELLS	numeric	8

Variables in Pollutant Loads by County File (CNTY.TXT)

NAME	LABEL	TYPE	LENGTH
FIPS	FEDERAL INFORMATION PROC. SYSTEM CODE	character	5
CNTYNM	COUNTY NAME	character	40
MADI	MAJOR DISCHARGE INDICATOR	character	1
NO_FACIL	NUMBER OF FACILITIES	numeric	8
FLOWPROC	ANNUAL AVERAGE OF PROCESS FLOW IN MG	numeric	8
BODANN	BIOCHEMICAL OXYGEN DEMAND ANNUAL IN LB	numeric	8
TSSANN	TOTAL SUSPENDED SOLIDS ANNUAL IN LB	numeric	8
NANN	NITROGEN ANNUAL (TOTAL) IN LB	numeric	8
PANN	PHOSPHORUS ANNUAL (TOTAL) IN LB	numeric	8
ASANN	ARSENIC ANNUAL (TOTAL) IN LB	numeric	8
CDANN	CADMIUM ANNUAL (TOTAL) IN LB	numeric	8
CRANN	CHROMIUM ANNUAL (TOTAL) IN LB	numeric	8
CUANN	COPPER ANNUAL (TOTAL) IN LB	numeric	8
FEANN	IRON ANNUAL (TOTAL) IN LB	numeric	8
HGANN	MERCURY ANNUAL (TOTAL) IN LB	numeric	8
PBANN	LEAD ANNUAL (TOTAL) IN LB	numeric	8
ZNANN	ZINC ANNUAL (TOTAL) IN LB	numeric	8
OGANN	OIL AND GREASE ANNUAL (TOTAL) IN LB	numeric	8
FCBANN	FECAL COLIFORM BACTERIA ANNUAL IN CELLS	numeric	8

Variables in Typical Pollutant Concentrations File (TPC_MATRIX.TXT)

NAME	LABEL	TYPE	LENGTH
SIC	SIC CODE - 1987 FACILITY DESCRIPTION	character	4
SICNM	SIC NAME	character	40
DCCD	NCPDI-DISCHARGE CATEGORY CODE	character	4
DCNM	NCPID-DISCHARGE CATEGORY NAME	character	30
TPCBOD	TYP. POLLUTANT CONC. FOR BOD (mg/L)	numeric	8
TPCTSS	TYP. POLLUTANT CONC. FOR TSS (mg/L)	numeric	8
TPCN	TYP. POLLUTANT CONC. FOR P (mg/L)	numeric	8
TPCP	TYP. POLLUTANT CONC. FOR N (mg/L)	numeric	8
TPCFCB	TYP. POLL. FOR FCB (cell/100mL)	numeric	8
TPCAS	TYP. POLLUTANT CONC. FOR AS (mg/L)	numeric	8
TPCCD	TYP. POLLUTANT CONC. FOR CD (mg/L)	numeric	8
TPCCR	TYP. POLLUTANT CONC. FOR CR (mg/L)	numeric	8
TPCCU	TYP. POLLUTANT CONC. FOR CU (mg/L)	numeric	8
TPCFE	TYP. POLLUTANT CONC. FOR FE (mg/L)	numeric	8
TPCPB	TYP. POLLUTANT CONC. FOR PB (mg/L)	numeric	8
TPCHG	TYP. POLLUTANT CONC. FOR HG (mg/L)	numeric	8
TPCZN	TYP. POLLUTANT CONC. FOR ZN (mg/L)	numeric	8
TPCOG	TYP. POLLUTANT CONC. FOR OG (mg/L)	numeric	8
TPCPCB	TYP. POLLUTANT CONC. FOR PCB (mg/L)	numeric	8
TPCCHP	TYP. POLLUTANT CONC. FOR CHP (mg/L)	numeric	8
OPDAYS	OPERATING DAYS	numeric	8
PFACTOR	PROCESS FACTOR	numeric	8
WINCOEF	WINTER COEFFICIENT	numeric	8
SPRCOEF	SPRING COEFFICIENT	numeric	8
SUMCOEF	SUMMER COEFFICIENT	numeric	8
FALCOEF	FALL COEFFICIENT	numeric	8
SDAC2	SPECIAL DISCHARGE ACTIVITY CODES	character	2
EPAINDCD	EPA-INDUSTRIAL CATEGORY CODE	character	2

EPAINDNM	EPA-INDUSTRIAL CATEGORY NAME	character	25
OPDAYS_E	OPERATING DAYS - PER EPA'S EFFLUENT CHARACTERISTICS GUIDELINES	numeric	8
TPCBOD_B	TYP. POLLUTANT CONC. FOR BOD (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCTSS_B	TYP. POLLUTANT CONC. FOR TSS (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCN_B	TYP. POLLUTANT CONC. FOR P (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCP_B	TYP. POLLUTANT CONC. FOR N (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCFCB_B	TYP. POLL. FOR FCB (cell/100mL) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCAS_B	TYP. POLLUTANT CONC. FOR AS (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCCD_B	TYP. POLLUTANT CONC. FOR CD (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCCR_B	TYP. POLLUTANT CONC. FOR CR (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCCU_B	TYP. POLLUTANT CONC. FOR CU (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCFE_B	TYP. POLLUTANT CONC. FOR FE (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCPB_B	TYP. POLLUTANT CONC. FOR PB (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCHG_B	TYP. POLLUTANT CONC. FOR HG (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCZN_B	TYP. POLLUTANT CONC. FOR ZN (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCOG_B	TYP. POLLUTANT CONC. FOR OG (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCPCB_B	TYP. POLLUTANT CONC. FOR PCB (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8
TPCCHP_B	TYP. POLLUTANT CONC. FOR CHP (mg/L) - PER EPA'S BEST AVAILABLE TECHNOLOGY CONC.	numeric	8

Variables in Typical Flows by SIC Code File (TYPICAL_FLOWS.TXT)

VARIABLE	LABEL	TYPE	LENGTH
SIC	STANDARD INDUSTRIAL CLASSIFICATION CODE	character	11
P_FLOW	PROCESS FLOW (MGD)	numeric	8
PF_NOBS	NUMBER OF OBSERVATIONS USED TO GENERATE TYPICAL PROCESS FLOW VALUE	numeric	8
COMBFLOW	COMBINED FLOW (MGD)	numeric	8
CBF_NOBS	NUMBER OF OBSERVATIONS USED TO GENERATE TYPICAL COMBINED FLOW VALUE	numeric	8
COOLFLOW	COOLING FLOW (MGD)	numeric	8
COF_NOBS	NUMBER OF OBSERVATIONS USED TO GENERATE TYPICAL COOLING FLOW VALUE	numeric	8

Variables in Weather Station File (GUSTA_ID.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
STNO	Weather Station Number	character	8
STANAME	Weather Station Name	character	23
BEG_MONT	First month of record period	numeric	8
BEG_YEAR	First year of record period	numeric	8
END_MONT	Last month of record period	numeric	8
END_YEAR	Last year of record period	numeric	8
LAT1	Latitude in Decimal Degrees	numeric	8
LON1	Longitude in Decimal Degrees	numeric	8
STATE	State	character	2
COUNTY	County Name	character	20
UNIQUE	Unique Code (EDA and FDA)	numeric	8
HUC	Cataloging Unit Numeric	numeric	8
EDACDA	EDA/CDA/FDA 5-Digit Code	character	5
EDA_NAME	EDA Name	character	50

Variables in Daily Weather Data File (GU_WEA.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
STNO	Weather Station Number	character	8
YEARDAY	Year and Day	character	5
YEAR	2 Digit Year	character	2
MON	Month	numeric	8
DAY	Julian Day	character	2
PCP_MM	Precipitation data in mm	numeric	8
PCPSRCE	n0=pcp not missing, sw=snow/10(pcp missing)	character	2
LOW	Temperature-Low in Degrees Centigrade	numeric	8
TMPLSRCE	n0 if Temperature-Low data is not missing	character	2
HIGH	Temperature-High in Degrees Centigrade	numeric	8
TMPHSRCE	n0 if Temperature-High data is not missing	character	2
UNIQUE	Unique Code (EDA and FDA)	numeric	8
EDACDA	EDA/CDA/FDA 5-Digit Code	character	5

Variables in Monthly Weather Data File (GUAVGWEA.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
UNIQUE	CAF Polygon Code	numeric	8
YEARDAY	Year + Julian Day	character	5
CLOSEST	Closest Subbasin (source of data)	numeric	8
PCP_AVG	Avg. PCP (mm) of All Stns. in Subbasin	numeric	8
LOWAVG	Avg. Tmp-L (C) of All Stns. in Subbasin	numeric	8
HIGHAVG	Avg. Tmp-H (C) of All Stns. in Subbasin	numeric	8

Variables in Routing Scheme by UNIQUE File (GU_ROUT.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
UNIQUE	Subbasin Code	numeric	8
UNIQUE1	If Not -1, Next Subbasin To Be Routed	numeric	8
UNIQUE2	If Not -1, Next Subbasin To Be Routed	numeric	8
UNIQUE3	If Not -1, Next Subbasin To Be Routed	numeric	8
HUC	Hydrologic Cataloging Unit	numeric	8
EDACDA	EDA/CDA Code	character	5
LANDSQMI	Unique Land Polygon Area (sqmi)	numeric	8

Variables in Pollutant Loads by Virtual Basin (Land Use) File (GU_SBS.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
UNIQUE	11 Characters Subbasin Code	numeric	8
YEAR	Year	character	2
MONTH	Month	character	2
LUSE	Land Use Abbrev. Name (Virtual Basin)	character	4
LUSE1	Land Use Abbrev. Name (Few Categories)	character	4
IRRIG	Irrigated Crop =1, Nonirrigated Crop = 0	character	1
AREA_KM2	Area Of The Subbasin (km2) (SWAT)	numeric	8
PCP_MM	Precipitation (mm)	numeric	8
TMPAVG	Average Temperature (C)	numeric	8
FLOW_SBS	Total Flow (MG)	numeric	8
SURQ_SBS	Surface Flow (MG)	numeric	8
LATQ_SBS	Lateral Flow (MG)	numeric	8
GWQ_SBS	Groundwater Flow (MG)	numeric	8
TSS_SBS	Total Suspended Solids (lbs)	numeric	8
TN_SBS	Total Nitrogen (lbs)	numeric	8
TP_SBS	Total Phosphorus (lbs)	numeric	8
HUC	Hydrologic Cataloging Unit	numeric	8
EDACDA	EDA/CDA Code	character	5

Variables in Pollutant Loads by UNIQUE File (GU_BSB.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
UNIQUE	11 Characters Subbasin Code	numeric	8
YEAR	Year	character	2
MONTH	Month	character	2
AREA_KM2	Area of the unique (km2) (SWAT)	numeric	8
PCP_MM	Precipitation (mm)	numeric	8
TMPAVG	Average Temperature (C)	numeric	8
FLOW_BSB	Total Flow (MG)	numeric	8
SURQ_BSB	Surface Flow (MG)	numeric	8
LATQ_BSB	Lateral Flow (MG)	numeric	8
GWQ_BSB	Groundwater Flow (MG)	numeric	8
TSS_BSB	Total Suspended Solids (lbs)	numeric	8
TN_BSB	Total Nitrogen (lbs)	numeric	8
TP_BSB	Total Phosphorus (lbs)	numeric	8
HUC	Hydrologic Cataloging Unit	numeric	8
EDACDA	EDA / CDA Code	character	5

Variables in Stream Routing File (GU_RCH.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
UNIQUE	11 Characters Subbasin Code	numeric	8
YEAR	Year	character	2
MONTH	Month	character	2
AREA_KM2	Area of the unique (km2) (SWAT)	numeric	8
FLOW_RCH	Total Flow (MG)	numeric	8
TSS_RCH	Total Suspended Solids (lbs)	numeric	8
TN_RCH	Total Nitrogen (lbs)	numeric	8
TP_RCH	Total Phosphorus (lbs)	numeric	8
HUC	Hydrologic Cataloging Unit	numeric	8
EDACDA	EDA/CDA Code	character	5

Variables in Pollutant Loads by Watershed File (NPS_EDA1.TXT)

VARIABLE	LABEL	TYPE	LENGTH
EDACDA	EDA/CDA Watershed Code	character	5
EDA_NAME	EDA Name	character	50
YEAR	Year	character	2
LEDASQMI	Land EDA/CDA Area (sqmi)	numeric	8
FLOW_BSB	Total Flow (MG) - (not routed)	numeric	8
SURQ_BSB	Surface Flow (MG) - (not routed)	numeric	8
LATQ_BSB	Lateral Flow (MG) - (not routed)	numeric	8
GWQ_BSB	Groundwater Flow (MG) - (not routed)	numeric	8
FLOW_RCH	Total Flow (MG) - (routed)	numeric	8
TSS_BSB	TSS (lbs) - (not routed)	numeric	8
TSS_RCH	TSS (lbs) - (routed)	numeric	8
TN_BSB	Total Nitrogen (lbs) - (not routed)	numeric	8
TN_RCH	Total Nitrogen (lbs) - (routed)	numeric	8
TP_BSB	Total Phosphorus (lbs) - (not routed)	numeric	8
TP_RCH	Total Phosphorus (lbs) - (routed)	numeric	8

Variables in Pollutant Loads by Watershed and Land Use File (NPS_EDA2.TXT)

VARIABLE	LABEL	TYPE	LENGTH
EDACDA	EDA/CDA Code	character	5
YEAR	Year	character	2
LUSE1	Land Use Abbrev. Name (Few Categories)	character	4
FLOW_SBS	Total Flow (MG)	numeric	8
SURQ_SBS	Surface Flow (MG)	numeric	8
LATQ_SBS	Lateral Flow (MG)	numeric	8
GWQ_SBS	Groundwater Flow (MG)	numeric	8
TSS_SBS	Total Suspended Solids (lbs)	numeric	8
TN_SBS	Total Nitrogen (lbs)	numeric	8
TP_SBS	Total Phosphorus (lbs)	numeric	8

Variables in Pollutant Loads by Hydrologic Cataloging Unit File (NPS_HUC1.TXT)

VARIABLE	LABEL	TYPE	LENGTH
HUC	USGS 8-Digit cataloging Unit	numeric	8
YEAR	Year	character	2
HUCSQMI	HUC Area (sqmi) - Source: CAF	numeric	8
FLOW_BSB	Total Flow (MG) - (not routed)	numeric	8
SURQ_BSB	Surface Flow (MG) - (not routed)	numeric	8
LATQ_BSB	Lateral Flow (MG) - (not routed)	numeric	8
GWQ_BSB	Groundwater Flow (MG) - (not routed)	numeric	8
TSS_BSB	TSS (lbs) - (not routed)	numeric	8
TN_BSB	Total Nitrogen (lbs) - (not routed)	numeric	8
TP_BSB	Total Phosphorus (lbs) - (not routed)	numeric	8

Variables in Pollutant Loads by Hydrologic Cataloging Unit and Land Use File (NPS_HUC2.TXT)

VARIABLE	LABEL	TYPE	LENGTH
HUC	Hydrologic Cataloging Unit	numeric	8
YEAR	Year	character	2
LUSE1	Land Use Abbrev. Name (Few Categories)	character	4
FLOW_SBS	Total Flow (MG)	numeric	8
SURQ_SBS	Surface Flow (MG)	numeric	8
LATQ_SBS	Lateral Flow (MG)	numeric	8
GWQ_SBS	Groundwater Flow (MG)	numeric	8
TSS_SBS	Total Suspended Solids (lbs)	numeric	8
TN_SBS	Total Nitrogen (lbs)	numeric	8
TP_SBS	Total Phosphorus (lbs)	numeric	8

Variables in Pollutant Loads by UNIQUE File (NPS_UNI1.TXT)

VARIABLE	LABEL	TYPE	LENGTH
UNIQUE	Unique Code	numeric	8
YEAR	Year	character	2
LANDSQMI	Unique Land Area (sqmi)	numeric	8
FLOW_BSB	Total Flow (MG) - (not routed)	numeric	8
SURQ_BSB	Surface Flow (MG) - (not routed)	numeric	8
LATQ_BSB	Lateral Flow (MG) - (not routed)	numeric	8
GWQ_BSB	Groundwater Flow (MG) - (not routed)	numeric	8
FLOW_RCH	Total Flow (MG) - (routed)	numeric	8
TSS_BSB	TSS (lbs) - (not routed)	numeric	8
TSS_RCH	TSS (lbs) - (routed)	numeric	8
TN_BSB	Total Nitrogen (lbs) - (not routed)	numeric	8
TN_RCH	Total Nitrogen (lbs) - (routed)	numeric	8
TP_BSB	Total Phosphorus (lbs) - (not routed)	numeric	8
TP_RCH	Total Phosphorus (lbs) - (routed)	numeric	8
HUC	USGS 8-Digit cataloging Unit	numeric	8
EDACDA	EDA/CDA Watershed Code	character	5

Variables in Pollutant Loads by Unique and Land Use File (NPS_UNI2.TXT)

VARIABLE	LABEL	TYPE	LENGTH
UNIQUE	11 Character Subbasin Code	numeric	8
YEAR	Year	character	2
LUSE1	Land Use Abbrev. Name (Few Categories)	character	4
FLOW_SBS	Total Flow (MG)	numeric	8
SURQ_SBS	Surface Flow (MG)	numeric	8
LATQ_SBS	Lateral Flow (MG)	numeric	8
GWQ_SBS	Groundwater Flow (MG)	numeric	8
TSS_SBS	Total Suspended Solids (lbs)	numeric	8
TN_SBS	Total Nitrogen (lbs)	numeric	8
TP_SBS	Total Phosphorus (lbs)	numeric	8
HUC	Hydrololgic Cataloging Unit	numeric	8
EDACDA	EDA/CDA Code	character	5

Variables in Pollutant Loads by State File (NPS_STA1.TXT)

VARIABLE	LABEL	TYPE	LENGTH
STNM	State Name	character	11
STATSQMI	State Area (sq. mi.)	numeric	8
PERCSTAT	Percent State in Study Area	numeric	8
FLOW_BSB	Total Flow (MG) - (not routed)	numeric	8
SURQ_BSB	Surface Flow (MG) - (not routed)	numeric	8
LATQ_BSB	Lateral Flow (MG) - (not routed)	numeric	8
GWQ_BSB	Groundwater Flow (MG) - (not routed)	numeric	8
TSS_BSB	TSS (lbs) - (not routed)	numeric	8
TN_BSB	Total Nitrogen (lbs) - (not routed)	numeric	8
TP_BSB	Total Phosphorus (lbs) - (not routed)	numeric	8

Variables in Pollutant Loads by County File (NPS_CTY1.TXT)

NAME	LABEL	TYPE	LENGTH
FIPS	FIPS Code	character	5
CNTYNAME	County name	character	40
CNTYSQMI	County Area (sq. mi.)	numeric	8
PERCCNTY	Percent County in Study Area	numeric	8
FLOW_BSB	Total Flow (MG) - (not routed)	numeric	8
SURQ_BSB	Surface Flow (MG) - (not routed)	numeric	8
LATQ_BSB	Lateral Flow (MG) - (not routed)	numeric	8
GWQ_BSB	Groundwater Flow (MG) - (not routed)	numeric	8
TSS_BSB	TSS (lbs) - (not routed)	numeric	8
TN_BSB	Total Nitrogen (lbs) - (not routed)	numeric	8
TP_BSB	Total Phosphorus (lbs) - (not routed)	numeric	8

Variables in Crop Information File (GU_CROP.TXT)

VARIABLE	LABEL	TYPE	LENGTH
LUSE	Land Use (crop) Abbreviation	character	4
LUSENM	Land use (crop) Name	character	25
BE	Biomass-Energy Ratio	numeric	8
HI	Harvest Index	numeric	8
TO	Optimal Temp. for Plant Growth (C)	numeric	8
TB	Min. Temp. for Plant Growth (C)	numeric	8
BLAI	Max. Potential Leaf Area Index	numeric	8
DLAI	Fraction Grow. Seas. Leaf Area Declines	numeric	8
DLP1	1st Point Optimal Leaf Area Dev. Curve	numeric	8
DLP2	2nd Point Optimal Leaf Area Dev. Curve	numeric	8
GSI	Maximum Stomatal Conductance	numeric	8
CHTMX	Maximum Crop Height (meters)	numeric	8
RDMX	Maximum Rooting Depth (mm)	numeric	8
PT2	CO2 Concentration in Future Atmosphere	numeric	8
CVM	Min. Value of C Factor for H2O Erosion	numeric	8
WSYF	Lower Limit of Harvest Index	numeric	8
IRD	Vegetation for Crop (1)annual (2)peren.	numeric	8
WAVP	Parm Relating Vapor Pres. Deficit to WA	numeric	8
VPTH	Threshold VPD (SPA) (F=1)	numeric	8
VPD2	VPD Value (KPA) / F2 1	numeric	8

Variables in Tillage Information File (GU_TILL.TXT)

VARIABLE	LABEL	TYPE	LENGTH
TILL_NO	Tillage Number	numeric	8
EQ_NM	Equipment Name	character	8
COST	Cost of Operation ($/ha)	numeric	8
EFFMIX	Mixing Efficiency of Operat (0-1 range)	numeric	8
SURFROUG	Surface Roughness Created by Operation	numeric	8
TDEPTH	Tillage Depth (mm)	numeric	8
RHEIGHT	Ridge Height (mm)	numeric	8
RINTERV	Ridge Interval (m)	numeric	8
FDH	Furrow Dike Height (mm)	numeric	8
FDI	Furrow Dike Interval (m)	numeric	8
OPCODE	Operation Code	numeric	8
HEFF	Harvest Efficiency (0-1 range)	numeric	8
HINDEX	Harvest Index (0-0.95 range)	numeric	8
EQ_DES	Equipment Description	character	26
EQ_COST	Cost of Equipment File Name	character	4

Variables in Fertilizer Information File (GU_FERT.TXT)

VARIABLE	LABEL	TYPE	LENGTH
FERT_NM	Fertilizer Number	character	10
MIN_N	Mineral Nitrogen (kg/ha)	numeric	8
MIN_P	Mineral Phosphorus (kg/ha)	numeric	8
ORG_N	Organic Nitrogen (kg/ha)	numeric	8
ORG_P	Organic Phosphorus (kg/ha)	numeric	8
AMM_N	Ammonium Nitrogen (kg/ha)	numeric	8

Variables in Upstream Source Pollutant Loads File (GU_UPSTR.TXT)

NAME	LABEL	TYPE	LENGTH
UPSTR_ID	Upstream ID Code	numeric	8
UPSTR_NM	Upstream River Name	character	50
NAS_ID	NASQAN Station ID	numeric	8
RIVER_NM	River Name of NASQAN	character	40
UPSTSQMI	Tot. Area Above POE (sqmi)	numeric	8
NASQSQMI	Total Area Above NASQAN (sqmi)	numeric	8
P_FACTOR	Pror. Factor: upstrsqmi / nasqsqmi	numeric	8
E_LAT1	Latitude POE (degrees decimal)	numeric	8
E_LON1	Longitude POE (degrees decimal)	numeric	8
LAT1	Latitude NASQAN (degrees decimal)	numeric	8
LON1	Longitude NASQAN (degrees decimal)	numeric	8
UNIQUE	Unique Polygon Code in CAF	numeric	8
HUC	8-Digit Cataloging Unit (numeric)	numeric	8
HHUC	8-Digit Cataloging Unit (character)	character	8
EDACDA	EDA/CDA Code	character	5
EDA_NAME	EDACDA Name	character	60
STATE	State Code	character	11
FIPS	FIPS Codes	character	25
FIPS_NM	FIPS Names	character	60
FLOW_LT1	Long Term Avg. Flow (MG) at POE	numeric	8
FLOWANN1	Annual Flow (MG) at POE	numeric	8
FLOWFAL1	Fall Flow (MG) at POE	numeric	8
FLOWSPR1	Spring Flow (MG) at POE	numeric	8
FLOWSUM1	Summer Flow (MG) at POE	numeric	8
FLOWWIN1	Winter Flow (MG) at POE	numeric	8
SSANN1	Annual Susp. Solids (lbs) at POE	numeric	8
SSFAL1	Fall Susp. Solids (lbs) at POE	numeric	8
SSSPR1	Spring Susp. Solids (lbs) at POE	numeric	8
SSSUM1	Summer Susp. Solids (lbs) at POE	numeric	8

SSWIN1	Winter Susp. Solids (lbs) at POE	numeric	8
DSANN1	Annual Diss. Solids (lbs) at POE	numeric	8
DSFAL1	Fall Diss. Solids (lbs) at POE	numeric	8
DSSPR1	Spring Diss. Solids (lbs) at POE	numeric	8
DSSUM1	Summer Diss. Solids (lbs) at POE	numeric	8
DSWIN1	Winter Diss. Solids (lbs) at POE	numeric	8
TSSANN1	Annual TSS (lbs) at POE	numeric	8
TSSFAL1	Fall TSS (lbs) at POE	numeric	8
TSSSPR1	Spring TSS (lbs) at POE	numeric	8
TSSSUM1	Summer TSS (lbs) at POE	numeric	8
TSSWIN1	Winter TSS (lbs) at POE	numeric	8
TNANN1	Annual TN (lbs) at POE	numeric	8
TNFAL1	Fall TN (lbs) at POE	numeric	8
TNSPR1	Spring TN (lbs) at POE	numeric	8
TNSUM1	Summer TN (lbs) at POE	numeric	8
TNWIN1	Winter TN (lbs) at POE	numeric	8
ORGAANN1	Annual Organic (lbs) at POE	numeric	8
ORGAFAL1	Fall Organic (lbs) at POE	numeric	8
ORGASPR1	Spring Organic (lbs) at POE	numeric	8
ORGASUM1	Summer Organic (lbs) at POE	numeric	8
ORGAWIN1	Winter Organic (lbs) at POE	numeric	8
N2N3ANN1	Annual NO2+NO3 (lbs) at POE	numeric	8
N2N3FAL1	Fall NO2+NO3 (lbs) at POE	numeric	8
N2N3SPR1	Spring NO2+NO3 (lbs) at POE	numeric	8
N2N3SUM1	Summer NO2+NO3 (lbs) at POE	numeric	8
N2N3WIN1	Winter NO2+NO3 (lbs) at POE	numeric	8
NH4ANN1	Annual NH4 (lbs) at POE	numeric	8
NH4FAL1	Fall NH4 (lbs) at POE	numeric	8
NH4SPR1	Spring NH4 (lbs) at POE	numeric	8
NH4SUM1	Summer NH4 (lbs) at POE	numeric	8
NH4WIN1	Winter NH4 (lbs) at POE	numeric	8
TPANN1	Annual TP (lbs) at POE	numeric	8

TPFAL1	Fall TP (lbs) at POE	numeric	8
TPSPR1	Spring TP (lbs) at POE	numeric	8
TPSUM1	Summer TP (lbs) at POE	numeric	8
TPWIN1	Winter TP (lbs) at POE	numeric	8
AGANN1	Annual Silver (lbs) at POE	numeric	8
AGFAL1	Fall Silver (lbs) at POE	numeric	8
AGSPR1	Spring Silver (lbs) at POE	numeric	8
AGSUM1	Summer Silver (lbs) at POE	numeric	8
AGWIN1	Winter Silver (lbs) at POE	numeric	8
ASANN1	Annual Arsenic (lbs) at POE	numeric	8
ASFAL1	Fall Arsenic (lbs) at POE	numeric	8
ASSPR1	Spring Arsenic (lbs) at POE	numeric	8
ASSUM1	Summer Arsenic (lbs) at POE	numeric	8
ASWIN1	Winter Arsenic (lbs) at POE	numeric	8
CDANN1	Annual Cadmium (lbs) at POE	numeric	8
CDFAL1	Fall Cadmium (lbs) at POE	numeric	8
CDSPR1	Spring Cadmium (lbs) at POE	numeric	8
CDSUM1	Summer Cadmium (lbs) at POE	numeric	8
CDWIN1	Winter Cadmium (lbs) at POE	numeric	8
CRANN1	Annual Chromium (lbs) at POE	numeric	8
CRFAL1	Fall Chromium (lbs) at POE	numeric	8
CRSPR1	Spring Chromium (lbs) at POE	numeric	8
CRSUM1	Summer Chromium (lbs) at POE	numeric	8
CRWIN1	Winter Chromium (lbs) at POE	numeric	8
CUANN1	Annual Copper (lbs) at POE	numeric	8
CUFAL1	Fall Copper (lbs) at POE	numeric	8
CUSPR1	Spring Copper (lbs) at POE	numeric	8
CUSUM1	Summer Copper (lbs) at POE	numeric	8
CUWIN1	Winter Copper (lbs) at POE	numeric	8
FEANN1	Annual Iron (lbs) at POE	numeric	8
FEFAL1	Fall Iron (lbs) at POE	numeric	8
FESPR1	Spring Iron (lbs) at POE	numeric	8

FESUM1	Summer Iron (lbs) at POE	numeric	8
FEWIN1	Winter Iron (lbs) at POE	numeric	8
HGANN1	Annual Mercury (lbs) at POE	numeric	8
HGFAL1	Fall Mercury (lbs) at POE	numeric	8
HGSPR1	Spring Mercury (lbs) at POE	numeric	8
HGSUM1	Summer Mercury (lbs) at POE	numeric	8
HGWIN1	Winter Mercury (lbs) at POE	numeric	8
NIANN1	Annual Nickel (lbs) at POE	numeric	8
NIFAL1	Fall Nickel (lbs) at POE	numeric	8
NISPR1	Spring Nickel (lbs) at POE	numeric	8
NISUM1	Summer Nickel (lbs) at POE	numeric	8
NIWIN1	Winter Nickel (lbs) at POE	numeric	8
PBANN1	Annual Lead (lbs) at POE	numeric	8
PBFAL1	Fall Lead (lbs) at POE	numeric	8
PBSPR1	Spring Lead (lbs) at POE	numeric	8
PBSUM1	Summer Lead (lbs) at POE	numeric	8
PBWIN1	Winter Lead (lbs) at POE	numeric	8
ZNANN1	Annual Zinc (lbs) at POE	numeric	8
ZNFAL1	Fall Zinc (lbs) at POE	numeric	8
ZNSPR1	Spring Zinc (lbs) at POE	numeric	8
ZNSUM1	Summer Zinc (lbs) at POE	numeric	8
ZNWIN1	Winter Zinc (lbs) at POE	numeric	8

Note: POE = Point of Entrance to Estuarine Drainage Area (EDA)

Variables in Upstream Source Pollutant Loads File by EDA (GU_U_EDA.TXT)

NAME	LABEL	TYPE	LENGTH
EDACDA	EDA/CDA Code	character	5
SUB_NAME	Sub-System Name	character	50
FLOW_LT1	Long Term Avg. Flow (MG) at POE	numeric	8
FLOWANN1	Annual Flow (MG) at POE	numeric	8
FLOWFAL1	Fall Flow (MG) at POE	numeric	8
FLOWSPR1	Spring Flow (MG) at POE	numeric	8
FLOWSUM1	Summer Flow (MG) at POE	numeric	8
FLOWWIN1	Winter Flow (MG) at POE	numeric	8
SSANN1	Annual Susp. Solids (lbs) at POE	numeric	8
SSFAL1	Fall Susp. Solids (lbs) at POE	numeric	8
SSSPR1	Spring Susp. Solids (lbs) at POE	numeric	8
SSSUM1	Summer Susp. Solids (lbs) at POE	numeric	8
SSWIN1	Winter Susp. Solids (lbs) at POE	numeric	8
DSANN1	Annual Diss. Solids (lbs) at POE	numeric	8
DSFAL1	Fall Diss. Solids (lbs) at POE	numeric	8
DSSPR1	Spring Diss. Solids (lbs) at POE	numeric	8
DSSUM1	Summer Diss. Solids (lbs) at POE	numeric	8
DSWIN1	Winter Diss. Solids (lbs) at POE	numeric	8
TSSANN1	Annual TSS (lbs) at POE	numeric	8
TSSFAL1	Fall TSS (lbs) at POE	numeric	8
TSSSPR1	Spring TSS (lbs) at POE	numeric	8
TSSSUM1	Summer TSS (lbs) at POE	numeric	8
TSSWIN1	Winter TSS (lbs) at POE	numeric	8
TNANN1	Annual TN (lbs) at POE	numeric	8
TNFAL1	Fall TN (lbs) at POE	numeric	8
TNSPR1	Spring TN (lbs) at POE	numeric	8
TNSUM1	Summer TN (lbs) at POE	numeric	8
TNWIN1	Winter TN (lbs) at POE	numeric	8

ORGAANN1	Annual Organic (lbs) at POE	numeric	8
ORGAFAL1	Fall Organic (lbs) at POE	numeric	8
ORGASPR1	Spring Organic (lbs) at POE	numeric	8
ORGASUM1	Summer Organic (lbs) at POE	numeric	8
ORGAWIN1	Winter Organic (lbs) at POE	numeric	8
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N2N3FAL1	Fall NO2+NO3 (lbs) at POE	numeric	8
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N2N3SUM1	Summer NO2+NO3 (lbs) at POE	numeric	8
N2N3WIN1	Winter NO2+NO3 (lbs) at POE	numeric	8
NH4ANN1	Annual NH4 (lbs) at POE	numeric	8
NH4FAL1	Fall NH4 (lbs) at POE	numeric	8
NH4SPR1	Spring NH4 (lbs) at POE	numeric	8
NH4SUM1	Summer NH4 (lbs) at POE	numeric	8
NH4WIN1	Winter NH4 (lbs) at POE	numeric	8
TPANN1	Annual TP (lbs) at POE	numeric	8
TPFAL1	Fall TP (lbs) at POE	numeric	8
TPSPR1	Spring TP (lbs) at POE	numeric	8
TPSUM1	Summer TP (lbs) at POE	numeric	8
TPWIN1	Winter TP (lbs) at POE	numeric	8
AGANN1	Annual Silver (lbs) at POE	numeric	8
AGFAL1	Fall Silver (lbs) at POE	numeric	8
AGSPR1	Spring Silver (lbs) at POE	numeric	8
AGSUM1	Summer Silver (lbs) at POE	numeric	8
AGWIN1	Winter Silver (lbs) at POE	numeric	8
ASANN1	Annual Arsenic (lbs) at POE	numeric	8
ASFAL1	Fall Arsenic (lbs) at POE	numeric	8
ASSPR1	Spring Arsenic (lbs) at POE	numeric	8
ASSUM1	Summer Arsenic (lbs) at POE	numeric	8
ASWIN1	Winter Arsenic (lbs) at POE	numeric	8
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CDFAL1	Fall Cadmium (lbs) at POE	numeric	8

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CRSPR1	Spring Chromium (lbs) at POE	numeric	8
CRSUM1	Summer Chromium (lbs) at POE	numeric	8
CRWIN1	Winter Chromium (lbs) at POE	numeric	8
CUANN1	Annual Copper (lbs) at POE	numeric	8
CUFAL1	Fall Copper (lbs) at POE	numeric	8
CUSPR1	Spring Copper (lbs) at POE	numeric	8
CUSUM1	Summer Copper (lbs) at POE	numeric	8
CUWIN1	Winter Copper (lbs) at POE	numeric	8
FEANN1	Annual Iron (lbs) at POE	numeric	8
FEFAL1	Fall Iron (lbs) at POE	numeric	8
FESPR1	Spring Iron (lbs) at POE	numeric	8
FESUM1	Summer Iron (lbs) at POE	numeric	8
FEWIN1	Winter Iron (lbs) at POE	numeric	8
HGANN1	Annual Mercury (lbs) at POE	numeric	8
HGFAL1	Fall Mercury (lbs) at POE	numeric	8
HGSPR1	Spring Mercury (lbs) at POE	numeric	8
HGSUM1	Summer Mercury (lbs) at POE	numeric	8
HGWIN1	Winter Mercury (lbs) at POE	numeric	8
NIANN1	Annual Nickel (lbs) at POE	numeric	8
NIFAL1	Fall Nickel (lbs) at POE	numeric	8
NISPR1	Spring Nickel (lbs) at POE	numeric	8
NISUM1	Summer Nickel (lbs) at POE	numeric	8
NIWIN1	Winter Nickel (lbs) at POE	numeric	8
PBANN1	Annual Lead (lbs) at POE	numeric	8
PBFAL1	Fall Lead (lbs) at POE	numeric	8
PBSPR1	Spring Lead (lbs) at POE	numeric	8
PBSUM1	Summer Lead (lbs) at POE	numeric	8

PBWIN1	Winter Lead (lbs) at POE	numeric	8
ZNANN1	Annual Zinc (lbs) at POE	numeric	8
ZNFAL1	Fall Zinc (lbs) at POE	numeric	8
ZNSPR1	Spring Zinc (lbs) at POE	numeric	8
ZNSUM1	Summer Zinc (lbs) at POE	numeric	8
ZNWIN1	Winter Zinc (lbs) at POE	numeric	8

Note: POE = Point of Entrance to Estuarine Drainage Area (EDA)

Gulf of Mexico Land-Based Pollution Sources Inventory

Point Sources of Pollution

Point Source Inventory
The inventory includes background data and pollutant discharge estimates for 766 major and 8,147 minor direct point sources discharging in the watersheds and coastal drainage areas of the Gulf of Mexico.

The point source inventory consists of seven data files. Most users will find File 7 to be the most useful, because it contains information describing the facility (e.g. name, location, receiving water, major/minor facility designation, and type of industrial activity or level of wastewater treatment) and seasonal and annual estimates of discharges for each of the 8,913 facilities in the Inventory for the 15 pollutant parameters. In addition, all seven files also can be linked in a relational database framework through the common variable containing the facility permit number (NPID).

The pollutant loading estimates in the Inventory are based on a hierarchy of data sources. For point sources in the U.S. portions of the study area, the highest priority source is derived from data from the EPA's National Pollutant Discharge Elimination System (NPDES) program as reported in each facility's discharge monitoring report. When this information was not available, permitted discharge limits set for the facility are used. If neither monitoring or permit pollutant data were available, engineering values **[download ascii tables from the Data Products Link: typical pollutant concentrations (tpc_matrix.asc) and typical flows (typical_flow.asc)]** associated with the facility's industrial activity or level of wastewater treatment are used for the estimate (2).

The Point Source Loading Estimation Program (PSLEP),written in the Statistical Analysis System (SAS), uses several simple algorithms to generate the discharge estimates and maintains an audit trail of basis and source codes to provide the user with a means to evaluate the relative confidence that can be placed in the estimate. It also contains a set of statistically-based decision rules designed to screen out unreliable monitored data.

Results of the 1991 Point Source Inventory

A variety of results can be drawn from the analysis of the point source inventory. Some of the major findings are presented below:

- **Distribution of Facilities in Study Area**
  There are 766 major and 8,147 minor facilities in the study area. There are 6,909 active industrial facilities, 1,925 wastewater treatment plants, and 79 power plants.

Thirty six percent of the facilities (3,235 out of 8,913) in the study area are located in two watersheds, Atchafalaya/Vermilion Bays and Galveston Bay. No other single watershed in the Gulf of Mexico accounts for more than nine percent of the facilities in the region.

- **Important Discharge Activities for all Pollutants**
  The types of discharge activities that account for the greatest proportion of loads in the study area are wastewater treatment plants and pulp and paper mills.

  1. The City of New Orleans waste water treatment plant located in New Orleans, in the Mississippi River watershed, is the largest discharger of process flow, nitrogen, zinc and oil and grease.
  2. The Laroche Chemicals Inc. facility in Gramercy, St. James Parish (Lake Borgne watershed) is the largest industrial discharger of Total Suspended Solids, Arsenic, Cadmium, Iron, Lead, and Mercury in the region.
  3. Waste water treatment plants are the major type of point source discharges.
- **Process Flow**
  Process flow is the flow originated from production processes in industrial facilities and the waste effluent from waste water treatment plants. In combined pipes (process, cooling, storm water runoff, etc), process flow for the pipe accounts only for the process fraction of the total flow. Process flow is the most important parameter in the inventory as an indicator of pollutant discharges from point sources. Below are some findings on this parameter:
  1. Four watersheds in the study area account for over 50 percent of the total process flow in the Gulf of Mexico (1,121 billion gallons): Galveston Bay 22 percent, Mississippi River 12 percent, Lake Borgne 9 percent and Sabine Lake 8 percent.
  2. The source of the process flow for the Galveston Bay and Mississippi River watersheds is primarily WWTPs, while industry is the major source of process flow for the Lake Borgne and Sabine Lake watersheds.
  3. The 79 power plants in the study area contribute about 71 percent of the total flow discharged from all point source categories (WWTP, industry and power plants). Most of this flow is once-through cooling water, which has little net addition of pollutants. However, some power plants have process water discharges that are comparable to loads discharged from major industrial activities.

- **Relative Contribution of Discharges For Total Nitrogen**
  A variety of relative contributions can be obtained using the inventory for each pollutant parameter. Below are some findings for total nitrogen:

  By Major Watershed:

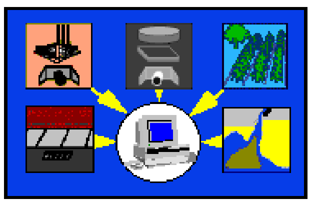
  1. The watersheds with the largest discharges of total nitrogen in the study area (100 million pounds) are Galveston Bay (27 percent), and Mississippi River (16 percent).
  2. Total nitrogen discharges from major and minor point sources accounts for 29 percent in Galveston Bay, and 18 percent in Mississippi River.

By State

1. Texas accounts for 45 percent of total nitrogen discharges in the study area (100 million pounds), followed by Louisiana (35 percent), Florida (12 percent), Alabama (5 percent), Mississippi (2 percent) and Georgia (1 percent).

By Discharge Activity:

1. Eight percent of total nitrogen point source discharges in the entire region come from wastewater treatment plants, and only 20 percent from industries. Organic chemicals account for 25 percent of the total nitrogen discharges from industries, followed by petroleum refining, miscellaneous industrial plants, pesticides plants, inorganic chemicals, pulp and paper, phosphatic fertilizer, nitrogeneous fertilizers, nonferrous metals, and others.



Challenges in Building and Interpreting a Point Source Regional Inventory

To build the Gulf of Mexico Inventory, pollution source information from many sources and of widely varying quality has to be compiled and synthesized into an integrated data set. The models, algorithms, decision rules, and simplifying assumptions used to develop loading estimates represent the best methods available to compile and process this diverse collection of data at a regional scale. The project team has tried to make the maximum use of available information, and to overcome the challenges of missing and unreliable data. It is important that users of the Inventory are aware of the limitations inherent in compiling and using a pollution source characterization at this scale. The most important of these are presented below.

- **Estimating Loads For All Facilities**
  Pollutant loads were estimated for all major and minor permitted and non-permitted point sources using NOAA's Point Source Loading Estimation Program (PSLEP). The amount of monitoring data available varied by pollutant, and industry type. Overall, monitoring data were generally available for Flow, BOD, TSS and phosphorus.

  Although a concerted effort was made to collect and use monitoring data, most of the pollutant discharge estimates, in particular for minor facilities in both countries, still rely heavily on typical pollutant concentration estimates. Because the inventory has a built-in audit trail, these typical estimates can be screened out by the user, which reduces the number of estimates available for analysis but increases the confidence level of the remaining values. The fact that the vast majority of permits for point source facilities in the study only require monitoring for a limited number of pollutants, it raises the question of whether monitoring for additional pollutants should be required, at least for the major facilities that contribute the bulk of the pollutant loadings. The inventory can be used to identify those major facilities for which additional permit requirements should be considered.

- **Assigning Facilities To Different Spatial Units**
  Spatial unit codes for pollutant aggregation purposes were assigned to all 8,913 facilities in the Gulf. When possible, the project team used the facility's latitude/ longitude coordinates to identify its location. The latitude/longitude sources included the facility itself, state lists, EPA's PCS, hardcopy maps and EPA's Industrial Facility Discharge (IFD) database.
  However, when this information was not available, facility location was estimated using the coordinates of the facility's zip code or the centroid of the city. This lack of locational data, particularly for minor facilities, hindered the accurate assignment of facilities to individual subbasins.

- **Quantifying The Accuracy Of The Estimates**
  The inventory provides resource managers throughout the Gulf with an overall picture of pollution with reasonable accuracy, allowing them to develop appropriate pollution control strategies and monitoring programs. The inventory also provides resource managers with a tool to examine with confidence the relative contributions of point source pollutant discharges, both within and among watersheds.
  However, as discussed before, the capability to generate absolute accurate discharge estimates is limited by the scarcity of monitored pollutant data. For many pollutants, loads were based on assumptions about typical pollutant concentrations in the waste stream, volume of flow in the pipe, and the type of wastewater (e.g., process, cooling, a combination of both, or domestic sewage effluent) discharged. Download tpc_matrix.asc to see data.
  Although it was not possible to quantify the error by assigning numerical confidence limits to the estimates, by tagging each estimate with a data source and computational basis code, we have been able to provide the user with a means of evaluating the relative confidence that can be placed in the estimate.

- **Producing Timely Estimates**
  The inventory is a snapshot in time -- a picture of pollution discharges in 1991. These loading estimates can be considered reasonably representative of discharges from 1992 to 1995, particularly for screening-level assessments. In general, this assumption is better for discharges from wastewater treatment plants, which vary less over time, than from industrial activities, which are more sensitive to changes in production levels tied to economic conditions.
  However, in many instances, a more recent inventory that is representative of discharges for a current year is required. NOAA has now acquired a capability to estimate loads that are only two years old in a short period of time (2-3 months) making use of its recently updated PSLEP algorithm.

- **Compiling a Comprehensive Inventory**
  The project team made an extensive effort to generate a comprehensive inventory of facilities in the Gulf of Mexico and believes the inventory contains a fairly complete listing of the dischargers in the study area for the given year. However, in such a large study area in any given time period, some facilities begin or change operations, others cease operating permanently, and some change ownership and name. Resolving discrepancies in the exact number, type, and discharge characteristics of facilities in an area is time- consuming and often unsuccessful. The accuracy of the information can continue to improve when future inventories are developed.

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Variables in Gulf of Mexico GIS File (GULF_OF_MEXICO_STUDY_AREA.ZIP)

VARIABLE	LABEL	TYPE	LENGTH
UNIQUE	Unique Polygon Code in CAF	numeric	8
EDACDA	4-digit Estuarine Drainage Area Code	character	4
NAME	Watershed Name	character	50
SUB_NAME	Watershed Subsystem Name	character	50
POLYCLAS	Text description of spatial area (based on CLASS)	character	36
P_TYPE	Text description of spatial area (based on POLYTYPE)	character	7
SUBEDA	Watershed Subsystem Code	character	1
OLDCAF	Old EDACDA Code	character	4
CLASS	Polygon Classification Code	numeric	8
HUC	Hydrologic Cataloging Unit	numeric	8
HHUC	Hydrologic Cataloging Unit	character	8
POLYTYPE	Integer code describing spatial area	numeric	8
REGION	Geographic Region Code ("G" = Gulf of Mexico)	character	1
AREA_MI2	Polygon Area (sq. mi.)	numeric	8
DR_CODE	Drainage Code ("E" = EDA, "F"=FDA, "I" = Interior Self Draining)	character	1
UNIQUE_ID	EDASUBEDA + POLYCLAS	character	50
EDA_NAME	Watershed Name + POLYCLAS designation	character	50
EDASUBEDA	5-digit Estuarine Drainage Area Code	character	5

Gulf of Mexico Land-Based Pollution Sources Inventory

Typical Pollutant Concentrations (TPC) for NCPDI Discharge Categories

- Go to download site

Code	NCPDI Discharge Category Name	SIC Codes	BOD mg/l	TSS mg/l	TN mg/l	TP mg/l	FCB c/l	As mg/l	Cd mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Pb mg/l	Hg ug/l	Zn mg/l	O & G mg/l	PCB ug/l	CHP ug/l	Operating Days	P-factor	Seasonality factor				SDAC	References (No. and Page)
																					winter	spring	summer	fall		
1	ASBESTOS	3292	16.0	26.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	250	0.75	0.250	0.250	0.250	0.250		(4) pp. 57-64, pp. 82-97
2	BAKERY PRODUCTS	2051, 2052, 2065, 2066, 2967	8.0	12.0	2.4	-	-	-	-	-	-	-	-	-	-	1.6	-	-	250	0.90	0.250	0.250	0.250	0.250		(3) see Table 1
3	BATTERY MFG.	3691, 3692	-	125.4	-	-	-	1.0	0.001	9.000	0.400	0.08	1.500	160.200	44.500	7.2	-	-	250	0.50	0.250	0.250	0.250	0.250		(1) Appendix B
4	BEVERAGE PRODUCTS Beverages	2082-85, 2087, 2095	219.6	34.2	16.8	-	-	-	-	-	-	-	-	-	-	4.5	-	-	250	0.90	0.250	0.250	0.250	0.250		(3) see Table 1
5	BEVERAGE PRODUCTS Soft Drinks	2086	70.0	40.0	8.6	4.0	-	-	-	-	-	-	-	-	-	-	-	-	250	0.90	0.250	0.250	0.250	0.250		(24) pp. 398-403, (2) pp. 3.2.1-11
6	CANNED & PRESERVED /a FRUITS & VEGETABLES	2031 - 2037	116.0	246.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	140, 260, 260	0.75, 0.75, 0.75	0.160, 0.175, 0.249	0.075, 0.0208, 0.249	0.334, 0.326, 0.249	0.424, 0.292, 0.249	FP, FQ, FT	(2) pp. 3.2.2-6, (8) pp.172-173 (9) p.36
7	CANNED & PRESERVED SEAFOOD PRODUCTS	2091, 2092	417.4	213.1	22.6	-	-	-	-	-	-	-	-	-	-	-	-	-	260, 120	1.00 , 1.00	0.343, 0.377	0.248 0.207	0.189, 0.243	0.207, 0.248	CV, CF	(6) pp. 43-62, 108-122, 213-278
8	Shellfish	2091, 2092	669.7	402.2	22.6	-	-	-	-	-	-	-	-	-	-	-	-	-	220, 120	1.00, 1.00	0.239, 0.239	0.179, 0.177	0.325, 0.325	0.259, 0.259	CW, CY	(7) pp. 100-114
9	Finfish	2091, 2092	380.7	180.7	22.6	-	-	-	-	-	-	-	-	-	-	-	-	-	220, 120	1.00, 1.00	0.185, 0.185	0.213, 0.213	0.297, 0.297	0.306, 0.306	CX, CZ	(7) pp. 150-186
10	CAR WASHES	7542	35.1	68.6	-	8.2	-	-	-	-	0.005	-	-	-	-	21.0	-	-	250	1.00	0.250	0.250	0.250	0.250		(3) See Table 1
11	CEMENT	3241	-	27.7	-	-	-	-	-	0.002	-	0.2	0.080	-	-	-	-	-	300	0.75	0.206	0.249	0.277	0.264		(2) pp. 3.1.18-7, (10) pp. 28-32

12	CHEMICAL PRODUCTS b/ Inorganic Chemicals	2812, 2813, 2816, 2819, 2892, 2899, 3274	-	46.0	1.9	-	-	0.04	0.030	0.070	0.070	0.02	0.200	1.800	0.200	-	-	-	350	1.00	0.250	0.250	0.250	0.250		(1) Appendix H
13	Nitrogenous Fertilizers	2873, 2875	-	8.7	4.4	-	-	-	-	0.010	-	-	-	-	-	-	-	-	250	0.75	0.250	0.250	0.250	0.250		(15) Section III
14	Phosphatic Fertilizers	2874	-	2.5	-	2.8	-	-	-	0.010	-	-	-	-	0.005	-	-	-	250	0.75	0.250	0.250	0.250	0.250		(16) Section III
15	Organic Chemicals c/	2821, 2823, 2824, 2851, 2865, 2893, 2895, 3952, 3953, 3955, 7535	23.6	47.7	33.4	-	-	0.03	0.003	0.700	0.100	-	0.030	3.600	0.300	15.5	-	-	350	0.50	0.250	0.250	0.250	0.250		(1) Appendix H (for metals), (26) pp. 145, 153, 278-280 (others)
16	Adhesives and Sealants d/	2891	3.1	4.2	-	0.2	-	-	-	0.500	1.000	-	-	-	1.000	-	-	-	250	0.50	0.250	0.250	0.250	0.250		Not regulated based upon NPDES permit related DMR's for 10 East Coast plants
17	Gum and Wood Chemicals	2861	69.8	27.0	-	-	-	0.03	-	0.300	0.700	-	0.006	-	0.200	-	-	-	250	0.75	0.250	0.250	0.250	0.250		(21) p. 49
18	Pesticides	2869, 2879	43.5	15.3	-	-	-	-	-	-	0.001	-	-	-	-	-	-	22.7	300	0.50	0.250	0.250	0.250	0.250		(28) pp. 69-74, 100-106 (others), (1) Section III (for metals)
19	Pharmaceutical	2831, 2833, 2834	83.0	108.0	-	-	-	-	-	0.050	0.090	-	0.050	0.300	0.300	-	-	-	365	0.50	0.250	0.250	0.250	0.250		(1) Section III: (43) Mean Values
20	Soaps and Detergents	2841-44	2.0	1.9	-	-	-	-	-	0.050	0.020	-	0.007	-	0.030	-	-	-	250	0.34	0.250	0.250	0.250	0.250		(40) pp. 12, 21
21	CONCRETE e/	3271-73, 3281	-	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	250	0.90	0.206	0.249	0.277	0.264		Not regulated-based upon DMR's for 7 plants
22	CLAY PRODUCTS Structural Clay Products	3251-59	14	25	-	-	-	-	0.02	-	-	1.7	-	-	-	-	-	-	250	0.9	0.25	0.25	0.25	0.25		(3) see Table 1

23	Pottery and Related Products	3261-69, 3275, 3295-97, 3299	21	33	-	-	-	-	0.06	0.02	-	0.6	0.9	-	0.24	-	-	-	250	0.9	0.25	0.25	0.25	0.25		(3) see Table 1
24	DAIRY PRODUCTS	2021-24, 2026	38.6	49	36.5	33.3	-	-	-	-	-	-	-	-	-	-	-	-	250	0.5	0.25	0.25	0.25	0.25		(2) pp. 5.1-16: (12) pp. 48-68
25	EDIBLE OILS	2079	45.3	47.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	250	0.9	0.25	0.25	0.25	0.25		(24) pp. 315-331, 530-586
26	ELECTRICAL PRODUCTS Electrical & Electronic Components	3624, 3641, 3671, 3672, 3674, 3676, 3679, 3699	21.4	10.9	7.3	1	-	0.03	0.05	0.09	0.2	0.3	0.1	0.7	0.2	4.2	-	-	250	1	0.25	0.25	0.25	0.25		(3) see Table 1
27	Power Transformers	3677, 3612	15.5	11	-	-	-	-	0.03	0.03	0.1	-	0.04	-	0.1	3.5	10	-	250	1	0.25	0.25	0.25	0.25		(1) Section III
28	FEEDLOTS f/	0211-0291	90	178.6	28.5	41	400	-	-	-	-	-	-	-	-	-	-	-	365	1	0.25	0.25	0.25	0.25		(2) pp. 3.2.2-6: (14) pp. 54-131
29	FISH HATCHERIES g/	921	4.8	6	0.7	0.1	-	-	-	-	-	-	-	-	-	-			365	1	0.003	0.426	0.426	0.144		(17) pp. 54-75
30	FOUNDRIES	3321-25, 3361, 3362, 3369	-	34	6.3	-	-	0.003	0.004	0.001	0.05	1.2	0.7	-	1.9	6	-	-	250	0.1	0.25	0.25	0.25	0.25		(1) Section III
31	FOOD AND BEVERAGES (MISC.)	2038, 2047, 2074-2076, 2097-2099, 5142, 5144, 5146, 5148, 5154, 5423	44.1	48	17.9	6.7	-	-	-	-	-	-	-	-	-	-	-	-	250	0.5	0.25	0.25	0.25	0.25		(3) see Table 1
33	GRAIN PROCESSING	2041, 2043-46, 2048	17.1	21.6	39.9	19.5	-	-	-	-	-	-	-	-	-	-	-	-	250	0.9	0.25	0.25	0.25	0.25		(3) see Table 1
34	HOSPITALS	8062, 8063, 8069	15	20	33.4	11.7	-	-	-	0.04	0.4	2	-	5.3	-	27.2	-	-	365	1	0.25	0.25	0.25	0.25		(22) pp. v-1-25, 26

35	IRON & STEEL h/	3312, 3313, 3315-17	-	12.3	2.9	-	-	0.02	0.01	0.02	0.02	0.1	0.04	-	0.1	2.5	-	-	350	0.1	0.245	0.272	0.255	0.238		(1) Section III
36	LAUNDRIES	7211 - 7219	122.9	79.5	-	2.7	-	-	-	-	-	-	-	-	-	-	-	-	250	1	0.25	0.25	0.25	0.25		(3) see Table 1
37	LEATHER TANNING	3111, 3131, 3142-3144, 3149, 3151, 3161, 3171, 3172, 3199	33	56	48.8	-	-	-	-	4.8	0.03	-	0.05	0.3	0.1	19.6	-	-	250	1	0.25	0.25	0.25	0.25		(1) Section III
38	METAL FINISHING Finishing	i/	-	11.2	-	-	-	-	0.1	0.6	0.8	-	0.2	-	0.5	11.8	-	-	250	0.1	0.25	0.25	0.25	0.25		(1) Section III
39	Coil Coating	3479, 3497	-	48.4	-	2.5	-	-	0.05	1.2	0.007	2.6	0.04	-	5.7	18.1	-	-	250	1	0.25	0.25	0.25	0.25		(1) Sec. III: (11) pp. 106-136, 187
40	Can Making	3411	-	12	-	4.1	-	0.5	0.08	0.08	0.6	0.4	0.1	60	0.3	10	-	-	250	0.1	0.25	0.25	0.25	0.25		(1) Section III
41	MACHINERY Instruments	3811-3873	6.9	11.2	5.9	1.3	-	0.1	0.03	0.2	0.3	0.5	0.1	10	0.4	5.9	-	-	250	0.1	0.25	0.25	0.25	0.25		(3) see Table 1
42	Machinery	3511-3599	10.1	10	3	0.9	-	0	0.01	0.07	0.1	0.5	0.01	2	0.1	4.3	-	-	250	0.1	0.25	0.25	0.25	0.25		(3) see Table 1
43	Miscellaneous Manufacturing	3914, 3915, 3931, 3944, 3949, 3951, 3961, 3962, 3964, 3993, 3995, 3999	8.9	7	25.8	0.6	-	0.2	0.02	0.1	1.5	0.3	0.07	3	0.3	3.5	-	-	250	0.1	0.25	0.25	0.25	0.25		(3) see Table 1
44	Shipbuilding	3731, 3732	-	26.7	-	-	-	0.06	0.07	0.1	0.2	3.4	0.09	1.7	0.3	2.2	-	-	250	1	0.25	0.25	0.25	0.25		(32) pp. 59, 62
45	Transportation Equipment Equipment	3711-3728, 3743-3799	12.6	11.9	3.6	0.7	-	0.01	0.05	0.03	0.1	0.8	0.1	1	0.2	3.4	-	-	250	0.9	0.25	0.25	0.25	0.25		(3) see Table 1
46	MINERAL MINING	1211, 1411-1499	-	9	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	250	1	0.25	0.25	0.25	0.25		(3) see Table 1
47	MISCELLANEOUS INDUSTRIAL, COMMERCIAL	j/	23.9	22.1	11.2	7	200	0.003	0.001	0.04	0.04	0.7	0.05	0.3	0.1	11.2	-	-	300	0.5	0.25	0.25	0.25	0.25		(42) pp. 36-87

48	NONFERROUS METALS k/ Primary Nonferrous Metals	3331, 3332, 3334-3339	-	26.7	8.5	-	-	0.04	0.02	0.05	0.1	-	0.07	-	0.05	7	-	-	300	0.5	0.25	0.25	0.25	0.25		(1) Appendix K, T
49	Primary Zinc l/	3333	-	1.1	-	-	-	0.5	0.08	0.08	0.6	-	0.1	-	0.3	-	-	-	300	0.5	0.25	0.25	0.25	0.25		(1) Appendix K
50	Secondary Nonferrous Metals	3341	-	126.3	-	-	-	0.3	0.09	0.06	0.2	-	1.7	-	0.5	0.3	-	-	300	0.5	0.25	0.25	0.25	0.25		(1) Appendix K, T
51	Nonferrous Metal Forming	3356, 3357, 3363	-	15.5	52.1	-	-	-	0.1	0.1	0.7	0.5	0.1	-	0.5	10	-	-	250	0.5	0.25	0.25	0.25	0.25		(25) pp. 649, 762-778
52	Aluminum Forming	3353-3355	-	34.4	-	-	-	-	0.002	3.3	9	-	0.03	-	8.1	34.6	-	-	250	0	0.25	0.25	0.25	0.25		(1) Section III
53	Copper Forming	3351	-	12	-	2.1	-	-	0.08	0.08	0.6	0.4	0.1	-	0.3	10	-	-	250	0	0.25	0.25	0.25	0.25		(1) Appendix K, Section III
54	ORE MINING AND DRESSING	1011, 1021, 1031, 1041, 1044, 1051, 1061, 1081, 1092, 1094	-	5	-	-	-	0.5	0.005	0.05	0.03	0.5	0.07	1	0.4	-	-	-	220	1	0.25	0.25	0.25	0.25		(3) see Table 1
55	PAVING AND ROOFING	2951, 2952, 3996	9.5	40	0.1	-	-	0.002	0.1	0.2	0.1	0.6	1	0.9	0.2	19.5	-	-	250	0.9	0.184	0.225	0.312	0.278		(27) pp. 4-10, 39
56	PETROLEUM REFINING	2911, 2992, 2999	13.5	26.1	6.8	-	-	-	-	0.1	0.01	-	0.005	0.9	0.1	17.1	-	-	350	0.25	0.25	0.25	0.25	0.25		(1) Section III
57	PHOTOGRAPHIC PROCESSING	7395	143.1	5.9	21	-	-	-	0.05	0.05	-	6.7	0.08	-	-	-	-	-	250	0.5	0.25	0.25	0.25	0.25		(1) Section III
58	PLASTICS MOLDING AND FORMING	3079, 3652	11.7	86.4	0.2	1.1	-	-	0.006	0.02	0.006	0.3	0.09	-	0.08	7.5	-	1.6	250	0.25	0.25	0.25	0.25	0.25		(29) pp. 100, 123-128
59	PORCELAIN ENAMELING	3431, 3469, 3611, 3631-33, 3639	-	12	-	4.1	-	0.2	0.08	0.08	0.6	0.4	0.1	-	0.3	10	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix M
60	PRINTING AND PUBLISHING	2711 - 2795	6	3.5	7.6	-	-	0.006	-	0.4	0.2	-	0.8	-	2.9	7	-	-	230	0.5	0.25	0.25	0.25	0.25		(41) pp. 69-93
61	PULP AND PAPER	2611 - 2655	17.3	28.4	1.4	-	-	-	-	0.03	0.01	-	0.01	0.1	0.2	-	-	-	350	0.9	0.242	0.261	0.247	0.252		(1) Sec. III, Appendix N

62	RENDERING m/	2011, 2013, 2016, 2017, 2077	44.1	58.8	10.8	2.9	400	-	-	-	-	-	-	-	-	-	-	-	250	0.75	0.25	0.25	0.25	0.25		(3) see Table 1
63	RUBBER PROCESSING	2822, 3021, 3031, 3041, 3069, 3293, 7534	33	40	-	-	-	-	-	-	-	-	0.01	-	0.4	15	-	-	250	0	0.25	0.25	0.25	0.25		(2) pp. 3.1.14-7, 3.1.5-8,
64	TIRE AND INNER TUBE	3011	7.2	40	-	-	-	-	-	-	-	-	-	-	-	10	-	-	250	0	0.25	0.25	0.25	0.25		(31) pp. 78-87
65	STEAM ELECTRIC Process Flows	4911	-	30	-	-	-	0.07	0.009	0.06	0.09	0.8	0.01	1.2	0.7	15	-	-	365, 36	0, 0, 0	0.288, 0288, 0.246	0.26, 0.26, 0.246	0.237, 0.237, 0.258	0.295, 0.295,. 0.246	SE	(33) pp. 110-130, 176-238
68	SUGAR PRODUCTS Beet Sugar	2063	68.5	478	-	-	-	-	-	-	-	-	-	-	-	-	-	-	250	0.75	0.25	0.25	0.25	0.25		(2) pp. 3.2.1-11, 2.3.2-6
69	Cane Sugar	2061, 2062	57	180.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	260	0.75	0.25	0.25	0.25	0.25		(35) p. 86: (36) p. 80
70	TEXTILE MFG. General Texttile Mfg	2311-2399, 2281-2284, 2293, 2294	22.4	49.1	-	-	-	0.02	0.003	0.06	0.06	-	0.06	0.8	0.5	26.3	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix O
71	Wool Scouring	2299	50	230.1	-	-	-	0.04	0.03	0.04	0.08	-	0.9	1	0.3	190	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix O
72	Wool Finishing	2231	25	60	-	-	-	0.02	0.006	0.4	0.02	-	0.1	-	2.3	-	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix O
73	Low Water Use Textile Processing	2211, 2221, 2241, 2295, 2296, 2298	30.4	88	-	-	-	-	0.005	0.01	0.04	-	0.08	-	2.3	-	-	-	250	1	0.25	0.25	0.25	0.25		(37) pp. 132, 195, 389
74	Woven Fabric Finishing	2261, 2262	22	48.7	-	-	-	0.02	0.002	0.02	0.06	-	0.04	0.8	0.4	14	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix O
75	Knit Fabric Finishing	2251-54, 2257-59, 2292	23.6	41	-	-	-	0.02	0.005	0.05	0.06	-	0.04	1.4	0.3	21	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix O
76	Carpet Finishing	2271, 2272, 2279	35	65	-	-	-	-	0.004	0.2	0.04	-	0.03	-	0.2	6	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix O
77	Stock and Yarn	2269	10	25	-	-	-	0.006	0.005	0.07	0.09	-	0.08	1	0.3	90	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix O

78	Nonwoven Mfg.	2297	35	65	-	-	-	-	0.004	0.2	0.04	-	0.03	-	0.2	4.8	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix O
79	Felted Fabric	2291	25	60	-	-	-	-	-	0.04	-	-	0.05	-	-	2.4	-	-	250	1	0.25	0.25	0.25	0.25		(1) Appendix O
80	TIMBER PRODUCTS Sawmills	2411-2429, 2661	38.7	31.8	-	-	-	-	-	1	0.1	-	0.04	-	0.5	9.8	-	-	250	0.9	0.25	0.25	0.25	0.25		(3) see Table 1
81	Plywood	2431-2499, 2511, 2512, 2517, 2521, 2531, 2541, 2591, 2599	20	33.5	-	-	-	-	-	-	-	-	-	-	-	15	-	-	250	0.9	0.25	0.25	0.25	0.25		(3) see Table 1
82	TRANSPORTATION Railroads	4011, 4013	17.4	19.9	-	-	-	-	-	0.2	-	-	-	-	-	10.2	-	-	365	0.9	0.25	0.25	0.25	0.25		(38) p. 6
83	Trucking	4131, 4151, 4221, 4171-4214, 4222, 4231	22.3	19.9	-	-	-	-	-	0.2	-	-	-	-	-	10.4	-	-	365	0.9	0.25	0.25	0.25	0.25		(39) p. II.4
84	Residentials	6513-6515, 7011-7041, 8811	113.9	156.8	14.2	10	2.00E+03	0.005	0.002	0.016	0.072	1.3	0.097	0.4	0.214	27.6	-	-	365	1	0.25	0.25	0.25	0.25	WR	-48
98	Water Supply Treatment Plants	4941	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	365	1	0.25	0.25	0.25	0.25	WA	-49
99	Sewerage Systems	4952	207.3	209.1	15.1	13	5.00E+07	0.034	0.054	0.234	0.224	6.3	0.116	0.7	0.869	50.7	-	0.8	365	1	0.267	0.267	0.222	0.244	TU	-50
			158.3	114.4	15.1	13	2.00E+05	0.034	0.054	0.092	0.146	2.5	0.059	0.6	0.502	27.6	-	0.8	365	1	0.267	0.267	0.222	0.244	TP	
			23.9	22.1	11.2	7	2000	0.032	0.011	0.043	0.037	0.7	0.045	0.3	0.165	11.2	-	0.6	365	1	0.267	0.267	0.222	0.244	TS	
			12	11.1	5.6	3.5	1000	0.016	0.006	0.022	0.019	0.35	0.023	0.2	0.083	5.6	-	0.3	365	1	0.267	0.267	0.222	0.244	TT	
	Recycled Cooling		-	30	-	-	-	0.002	0.01	0.05	0.05	0.5	0.06	0.4	0.08	-	-	-	-	-	-	-	-	-		(44) pp. 8-16
	Once Through Cooling		-	-	-	-	-	-	-	-	0.002	-	-	-	-	-	-	-	-	-	-	-	-	-		(45) pp. 278-282 (46) pp. 63-66 (47) pp. 244-247

Abbreviations: SIC, Standard Industrial Classification; P-factor, process pipe factor; BOD, Biochemical Oxygen Demand; TSS, Total Suspended Solids; TN, Total Nitrogen; TP, Total Phosphorus;

FCB, Fecal Coliform Bacteria; As, Arsenic; Cd, Cadmium; Cr, Chromium; Cu, Copper; Fe, Iron; Pb, Lead; Hg, Mercury; Zn, Zinc; O & G, Oil and Grease; PCB, Polychlorinated Biphenyls; CHP, Chlorinated Hydrocarbon Pesticides.

Special Discharge Activity Codes (SDAC): WR, residential code assigned based on SIC (SIC = 6513-6515, 7011-7041, 8811); WA, indicates that alum coagulation is the main treatment process; WF, indicates that iron treatment is the major treatment process;

TU, untreated wastewater; TP, primary wastewater treatment; TS, secondary wastewater treatment; TT, tertiary wastewater treatment.

Footnotes

a/Canned & Preserved Seafood. One outlying value was dropped in calculating mean values. Development document categories were consolidated into shellfish plants, finfish plants, and plants processing both shellfish and finfish to better reflect actual plants.

b/ Inorganic Chemicals. Iron is only found in the waste stream of two subcategories and was dropped to prevent skewing of results. Explosives are covered under inorganic chemical values due to difficulties in deriving realistic values.

c/ Organic Chemicals. Paint and ink plants covered by organic chemical values due to difficulties in deriving realistic values from the limited numbers of plants sampled and reported in the source documents.

d/Adhesives & Sealants. Not currently regulated but permitted in some states; values based on Discharge Monitoring Reports for 10 plants.

e/Concrete. Not currently regulated but permitted in some states, values based on Discharge Monitoring Reports for seven plants.

f/Feedlots. FCB is assumed to be equal to the best practicable technology regulated level. The only feedlots that are direct discharges are wet duck farming, and values represent this activity.

g/Fish Hatcheries. Includes cleaning waste stream and normal daily operations.

h/Iron & Steel. Ferroalloys are covered under this category.

i/Metal Finishing. This category is defined by EPA for 66 individual SIC categories: 2514, 2515, 2522, 2542, 3398, 3399, 3412, 3421, 3423, 3425, 3429, 3432, 3433, 3441, 3442, 3443, 3444, 3446, 3448, 3449, 3451, 3452, 3462, 3465, 3466, 3471, 3482, 3483, 3484, 3489, 3493, 3494, 3496, 3498, 3499, 3613, 3621, 3622, 3623, 3629, 3634-3636, 3643-48, 3651, 3661, 3662, 3673, 3675, 3678, 3693, 3694, 7531, 7692-7699.

j/Miscellaneous Industrial Commercial. Assumed to represent small package treatment plants with discharge characteristics similar to secondary treatment: 111, 112, 115, 116, 119, 131, 132, 133, 134, 139, 161, 171, 172, 173, 174, 175, 179, 181, 182, 191, 273, 711, 721, 722, 723, 724, 741, 742, 751, 752, 761, 762, 781, 782, 783, 811, 831, 851, 912, 913, 919, 971, 1099, 1221, 1222, 1231, 1241, 1311, 1321, 1381, 1382, 1389, 1521, 1522, 1531, 1541, 1542, 1611, 1622, 1623, 1629, 1711, 1721, 1731, 1741, 1742, 1743, 1751, 1752, 1761, 1771, 1781, 1791, 1793, 1794, 1795, 1796, 1799, 2015, 2053, 2064, 2068, 2096, 2111, 2121, 2131, 2141, 2273, 2281, 2282, 2284, 2519, 2656, 2657, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2796, 2835, 2836, 3052, 3053, 3061, 3081, 3082, 3083, 3084, 3085, 3086, 3087, 3088, 3089, 3291, 3364, 3365, 3366, 3463, 3491, 3492, 3495, 3625, 3663, 3669, 3695, 3911, 3942, 3965, 3991, 4111, 4119, 4121, 4141, 4142, 4215, 4225, 4226, 4311, 4412, 4424, 4432, 4449, 4481, 4482, 4489, 4491, 4492, 4493, 4499, 4512, 4513, 4522, 4581, 4612, 4613, 4619, 4724, 4725, 4729, 4731, 4741, 4783, 4785, 4789, 4812, 4813, 4822, 4832, 4833, 4841, 4899, 4922, 4923, 4924, 4925, 4931, 4932, 4939, 4953, 4959, 4961, 4971, 5011, 5012, 5013, 5014, 5015, 5021, 5023, 5031, 5032, 5033, 5039, 5043, 5044, 5045, 5046, 5047, 5048, 5049, 5051, 5052, 5063, 5064, 5065, 5074, 5075, 5078, 5082, 5083, 5084, 5085, 5087, 5088, 5091, 5092, 5093, 5094, 5099, 5111, 5112, 5113, 5122, 5131, 5136, 5137, 5139, 5141, 5143, 5145, 5147, 5149, 5153, 5159, 5162, 5169, 5171, 5172, 5181, 5182, 5191, 5192, 5193, 5194, 5198, 5199, 5211, 5231, 5251, 5261, 5271, 5311, 5331, 5399, 5411, 5421, 5431, 5441, 5451, 5461, 5499, 5511, 5521, 5531, 5541, 5551, 5561, 5571, 5599, 5611, 5621, 5632, 5641, 5651, 5661, 5699, 5712, 5713, 5714, 5719, 5722, 5731, 5734, 5735, 5736, 5812, 5813, 5912, 5921, 5932, 5941, 5942, 5943, 5944, 5945, 5946, 5947, 5948, 5949, 5961, 5962, 5963, 5983, 5984, 5989, 5992, 5993, 5994, 5995, 5999, 6011, 6019, 6021, 6022, 6029, 6035, 6036, 6061, 6062, 6081, 6082, 6091, 6099, 6111, 6112, 6141, 6153, 6159, 6162, 6163, 6211, 6221, 6231, 6282, 6289, 6311, 6321, 6324, 6331, 6351, 6361, 6371, 6399, 6411, 6512, 6517, 6519, 6531, 6541, 6552, 6553, 6712, 6719, 6722, 6726, 6732, 6733, 6792, 6794, 6798, 6799, 7221, 7231, 7241, 7251, 7261, 7291, 7299, 7311, 7312, 7313, 7319, 7322, 7323, 7331, 7334, 7335, 7336, 7338, 7342, 7349, 7352, 7353, 7359, 7361, 7363, 7371, 7372, 7373, 7374, 7375, 7376, 7377, 7378, 7379, 7381, 7382, 7383, 7384, 7389, 7513, 7514, 7515, 7519, 7521, 7532, 7533, 7536, 7537, 7538, 7539, 7549, 7622, 7623, 7629, 7631, 7641, 7812, 7819, 7822, 7829, 7832, 7833, 7841, 7911, 7922, 7929, 7933, 7941, 7948, 7991, 7992, 7993, 7996, 7997, 7999, 8011, 8021, 8031, 8041, 8042, 8043, 8049, 8051, 8052, 8059, 8071, 8072, 8082, 8092, 8093, 8099, 8111, 8211, 8221, 8222, 8231, 8243, 8244, 8249, 8299, 8322, 8331, 8351, 8361, 8399, 8412, 8422, 8611, 8621, 8631, 8641, 8651, 8661, 8699, 8711, 8712, 8713, 8721, 8731, 8732, 8733, 8734, 8741, 8742, 8743, 8744, 8748, 8999, 9111, 9121, 9131, 9199, 9211, 9221, 9222, 9223, 9224, 9229, 9311, 9411, 9431, 9441, 9451, 9511, 9512, 9531, 9532, 9611, 9621, 9631, 9641, 9651, 9661, 9711, 9721, 9999,

k/Nonferrous Primary and Secondary. Subcategories are consolidated under primary and secondary category; based on flow weighted averages for current concentration levels from reference 1. A nitrogen value is not given for secondary nonferrous due to the wide range of concentration values given (3-3000 mg/1) in the source document.

1/Primary Zinc. Not regulated until 1984; values represent pretreatment levels as currently regulated.

m/Meat Processing and Rendering. FCB was derived from the EPA Development Document. Note that there is no value for oil and grease because it is defined as petroleum hydrocarbons and not animal fats and oils.

n/Steam Electric. Once-through cooling concentrations represent values for saline waters and not freshwater.

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Nitrogen - Human Health & Environmental Effects

Compound	Human Health Effects
Ammonia (NH_3)	• Exposure to high concentrations can result in temporary blindness, severe eye damage, and irritation of the respiratory tract. Toxic doses of ammonia acutely affect cerebral energy metabolism.
Nitrate (NO_3) [U.S. EPA's standard for drinking water = 10mg nitrate-N/L]	• Nitrates are changed to nitrites by natural biological processes. Large doses of nitrites can cause a form of anemia called methemoglobinemia. Nitrites ingested by humans can combine with amines and amides in the gastrointestinal tract to form nitrosamines, which have been identified as carcinogens.
Nitric oxide (NO)	• Experimental data indicate that NO is about one-fifth as toxic as NO_x but, in high concentrations, is capable of producing cyanosis and methemoglobinemia.
Nitrogen dioxide (NO_x)	• Exposure to nitrogen dioxide concentrations greater than 20ppm can result in emphysema, accelerated lung-tumor development, and death from pulmonary edema.

Compound	Environmental Effects
Ammonia (NH_3)	• Dissolved ammonia at concentrations above 0.2 mg/L may be toxic to fish, especially trout.
All forms	• All forms of nitrogen are potential contributors to eutrophication in lakes, estuaries, and some coastal waters.

Source: ACGIH, *Documentation of the Threshold Limit Values - Fourth Edition*, 1980, ACGIH, Cincinnati, 1980.

Phosphorus - Sources, Concentrations, and Loading Estimates

• Cropland	• Sources of phosphorus include commercial fertilizers, animal wastes from animal production facilities, crops sprayed with phosphate fertilizers, and irrigation water contaminated with phosphorus from soil and other agricultural runoff (EPA, 1993). The average estimate for cropland contributions to receiving waters is 1.56 million tons/year (EPA, 1986).
• Pasture and Rangeland	• Sources of phosphorus include animal wastes and decaying plants and animals. Manure can often increase the levels of phosphorus in the soil. When a storm occurs, these sources are often washed down to receiving waters. This in effect can increase levels of phosphorus in water and threaten the aquatic environment (EPA, 1993). The average estimate for pasture and rangeland contributions to receiving waters is 1.08 million tons/year (EPA, 1986).
• Forestland	• Sources of phosphorus include forest fertilizers, adsorbed to sediments, either in solution or aerial deposition, and removal of large quantities of vegetation. This leaches nutrients from soil to surface and ground waters and can therefore stimulate algal blooms in waterbodies (EPA, 1993). The average estimate for forestland contributions to receiving waters is 0.09 million tons/year (EPA, 1986).
• Urban Runoff	• Sources of phosphorus include municipal industrial treatment plant sludge and effluent. This is often used to fertilize agricultural lands and can therefore also create a problem of agricultural runoff (EPA, 1993). The average estimate for urban runoff contributions to receiving waters is 0.019 million tons/year (EPA, 1986).
• Other Sources of Phosphorus	• Other sources of phosphorus include precipitation, groundwater, and detergents Detergents have been named as one of the principal contributors of phosphorus to surface waters undergoing eutrophication. Phosphates are found in detergents because it forms less curd and scum and thus, make clothes and dishes look cleaner. Over 5 billion pounds of detergent is used annually in the U.S.; most is poured into the sewer systems of homes and industries using them. The major source of phosphorus in precipitation comes from dust generated over land from soil erosion and also industrial contamination of the atmosphere. In non-populated areas, the average phosphorus content is <30 ug/g, whereas in urban areas it can often exceed 100 ug/g. In groundwater, the phosphorus content is very low; the average is around 20 ug/g

average phosphorus content is <50 ug/g, whereas in urban areas it can often exceed 100 ug/g. In groundwater, the phosphorus content is very low; the average is around 20 ug/g (Wetzel, 1983).

Phosphorus - Environmental Effects

• Runoff and erosion	• Runoff and erosion can carry phosphorus to nearby water bodies. Dissolved inorganic phosphorus is probably the only form directly available to algae. Particulate and organic phosphorus delivered to waterbodies may later be released and may be available to algae when the bottom sediment of a waterbody becomes anaerobic, causing water quality problems (EPA, 1993).
• Animal wastes	• When manure enters surface waters, because of oxygen depletion, fish kills can occur. Furthermore, surface waters may be unsuitable for drinking, fishing, and other recreational uses. It can also cause eutrophication of ponds, lakes, and estuaries (EPA, 1993).
• Eutrophication	• Eutrophication can lead to hypoxia and anoxia, which can suffocate living resources (EPA, 1993).

Arsenic - Human Health and Environmental Effects

	Human Health Effects[1,2]
Carcinogen	yes
Teratogen	yes
Mutagen	yes
Embryotoxic	yes
Others	Acute or subacute arsenic exposure can lead to elevated tissue residues, appetite loss, gastrointestinal irritation, reduced growth, loss of hearing, blindness, dermatitis, degenerative changes in liver and kidney, cancer, chromosomal damage, birth defects, depigmentation of the extremities, gangrene ("blackfoot disease"), brain wave and electroencephalographic abnormalities, and death.
	Environmental Effects[2]
Algae	elevated levels of As may inhibit algal growth rates and reproduction
Crustacea	high concentrations of As canreduce growth rates and increase mortality rates
Mollusks	high concentrations of As can lead to abnormal development, depressed oxygen consumption, and depressed retraction
Echinoderms	elevated levels of As have been implicated in gametic and embryonic abnormalities
Fish	high levels of As can result in increased mortality rates and decreased growth rates

Sources: 1) Eisler, R. *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service, Biological Report 85(1.12), 1988. 2) GESAMP, *Review of Potentially Harmful Substances - Arsenic, Mercury and Selenium*, no. 28, 1986.

Cadmium - Human Health and Environmental Effects

	Human Health Effects[1]
Carcinogen	suspected
Teratogen	yes
Mutagen	no
Embryotoxic	yes
Others	suspected causal factors in many human pathologies: arteriosclerosis, central nervous system effects, emphysema, hypertension, Itai-Itai disease (weakened bones), kidney damage, lung/respiratory effects, renal dysfunction, tumors, and upper respiratory tract infection.
	Environmental Effects[2]
Algae	elevated levels of Cd inhibit algal growth rates
Coelenterates	increased levels of Cd can result in irreversible retraction of hydranths among some hydrozoans
Annelida	annelids appear to be very resistant to cadmium, with no effects being recorded at concentrations less than 100 ug/L
Crustacea	elevated levels of Cd reduce growth rates, increase mortality rates, and increase the incidents of carapace malformation
Mollusks	Cd bioaccumulates significantly in bivalve mollusks and, in high concentrations, leads to reduced growth rates
Echinoderms	no harmful effects recorded at concentrations less than 100 ug/L; group appears resistant to Cd
Tunicates	group appears semi-resistant to Cd
Fish	high levels of Cd can result in increased mortality rates, decreased growth rates, and reduced regenerative capabilities

Sources: 1) U.S. Environmental Protection Agency, *National Water Quality Inventory, 1984 Report to Congress and the Conservation Foundation*, State of the Environment 1982. 2) GESAMP, *Review of Potentially Harmful Substances - Cadmium, Lead, and Tin*, no. 22, 1985.

Gulf of Mexico Land-Based Pollution Sources Inventory

Classification of Major and Minor Industrial Facilities

The major/minor designation for the industrial point sources in the U.S. portion of the study area was assigned using a system developed by the Environment Protection Agency (EPA).

The Office of Water Enforcement and Permits designates an industrial discharger a major National Pollutant Discharge Elimination System (NPDES) permit by applying a numerical permit rating system to each industrial permit. This rating system assigns points to an individual permittee based on an assessment of five characteristics of the permittee's discharge.

The five characteristics or "rating criteria" are:

1) Toxic Pollutant Potential
2) Flow/Streamflow Volume
3) Traditional Pollutants
4) Potential Public Health Impacts
5) Water Quality Factors

To rate an industrial permit, an NPDES Industrial Permit Rating Worksheet must be filled out. A worksheet is filled out by evaluating the current permit application, the permit itself, and other monitoring forms kept in the individual permit file. The sum of these weighted point values is the permit's ranking. The point totals range from zero to a maximum of 265.

To generate the major industrial permit lists for each NPDES State and EPA Region, the data for each permittee is loaded into the NEIC computer system in Denver. The numbered boxes on the worksheet correlate to specific point values programmed into the computer. The computer adds the points for each criteria for each permit and arranges each permit by State in descending numerical order.

Currently, a permit assigned a point total of 80 points or higher is designated as a major permit. All permits below 80 points are designated as minor permits. This is an artificial cutoff point but one which maintains the total number of majors at a level consistent with the total number of major permits originally designated major during the first round of permitting. It also includes most permits which the NPDES permitting authorities collectively believe should be considered major dischargers.

Classification of Major and Minor WWTP Facilities

Waste Water Treatment Plants (WWTPs) are classified as being major if the flow is greater than one million gallons per day, or if the population served is greater than 10,000.

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Gulf of Mexico Land-Based Pollution Sources Inventory

The Point Source Loading Estimation Program (PSLEP)

The following is a summary of SAS programs written to produce point source pollutant loading estimates for the National Coastal Pollutant Discharge Inventory (NCPDI) Program. The program reference name is shown in bold type (e.g., PROGRAM A) and is the name used in the schematic for estimating point source discharges which details the inventory development process. The SAS program name is shown in parenthesis (e.g., [PROG_A. SAS]) next to the program reference name. Brief descriptions of program functions are listed as bullets. The summary also indicates in italics if the final program created one of the seven deliverable file in the inventory.

PROGRAM A (PROG_A.SAS)
Manipulates the PCS data obtained from EPA as follows:

- Reads state ASCII PCS file into the following SAS data sets:
- ST91F(active facility file)
- ST91F_I(inactive facility file)
- ST91P(active permit file)
- ST91P_I(inactive permit file)
- ST91M(active monitoring file)
- ST91M_I(inactive monitoring file)
- Creates the following variables: STTE, STATE, FIPS, FLAT1, and FLON1.
- Converts the latitude/longitude data (facility and pipe) reported as degrees/minutes/seconds to decimal degrees.
- Creates the active permit file by keeping only records where MLOC = 1 or MLOC = 2 and by deleting duplicates of parameter codes for a unique report designator (PDSG).
- Deletes any facility that does not have an NPDES number.
- Uses the value of the RCTY variable containing the facilityÕs city name to fill out the variable CYNM when data are missing.
- Enters label names for each field element.

PROGRAM B (PROG_B.SAS)
Creates File I - Facility File Coastal Counties

Manipulates the Facility File Entire State (ST91F) to obtain the Facility File Coastal Counties (CC91ACT) as follows:

- Appends individual state files of active facilities to create a single facility file for the region.
- Keeps only those records in NCPDI coastal counties.
- Assigns SIC codes where missing.
- Creates variables for one-, two-, and three-digit SIC codes to the SIC text name.
- Assigns FIPS codes where missing and associated basis code.
- Assigns hydrologic cataloging units and associated basis code.
- Assigns EDA/CDA codes and associated basis code.
- Assigns a code indicating the accuracy of the facility latitude/longitude coordinates.
- Flags facilities in six study areas.
- Assigns latitude/longitude coordinates when missing using sources such as NPDES permit
- application forms, state files, city, and ZIP code centroid. Also assigns associated basis code.
- Creates standardized facility name.
- Flags a record to indicate that one or more variables were edited based on the quality control checks.

PROGRAM C (PROG_C.SAS)
Creates File II- Monitoring File

Manipulates the PCS Monitoring File (ST91M) to obtain the Monitoring File (ST91M_N) as follows:

- Creates SEASON and MONTH variables.
- Replaces missing data in the variable RCUN and RUNT (monitoring units) with LCUC and
- LQUC data (permit units), respectively
- Changes the following characters in front of values to blanks:

  -(minus)
  <(less than)
  >(greater than)
  T(traces)
  E(estimate)

- Converts character data in the variables MCAV, MCMX, MCMN, MQAV, MQMX to numeric values MCAV1, MCMX1, MCMN1, MQAV1, MQMX1.
- Converts zero values to missing values.

PROGRAM D (PROG_D.SAS)
Creates File III - Permit File
Manipulates the PCS Permit File (ST91P) to obtain the Permit File (ST91P_N) as follows:

- Replaces non-numeric values with blanks for the variables LCAV, LCMX, LCMN, LQAV, and LQMX.
- Converts numeric data reported as character data to numerical values.
- Converts units from the PCS to units usable by the NCPDI (standardizes units).
- Back calculates flow in MGD from pollutant concentrations and pollutant loadings where concentration is in mg/l and loading is lbs./day.

- Obtains estimates of pipe flow from one of the following STORET parameter codes: 50050, 00056, 00058, 74060, 82220, 74020, 50049, 78932, 50047, 78720, 73676 (listed in order of preference).
- Computes permit-based pollutant loading estimates and assigns associated basis codes.
- Assigns label names for each field element.

PROGRAM E(PROG_E.SAS)
Manipulates the Monitoring File (ST91M_N) to obtain the Statistics File (ST_STAT1) as follows:

- Computes the following statistics for MCAV, MCMX, MCMN, MQAV and MQMX by NPID, DSCH, MLOC, and PRAM:

N (Number of observations with no missing values)
NMISS (Number of observations having missing values)MEAN (Mean)
STD (Standard deviation)
CV (Coefficient of variation)
MAX(Maximum value)
MIN (Minimum value)
RANGE (Range)

- Corrects the coefficient of variation (CV) for small sample size bias. Where the number of observations is 12 or less, this correction can make an appreciable difference. The equations are:

Coefficient of variation as computed: $CV = (STD * 100/MEAN)$
Coefficient of variation as corrected: $CV1 = CV * (1 + (1/(4*N)))$

PROGRAM F (PROG_F.SAS)
Creates File IV - Final Statistics Load File
Manipulates the Statistics File (ST_STAT1) to obtain the Final Statistics Load File (ST_STAT2) as follows:

- Converts units from the PCS to units usable by the NCPDI (standardizes units).
- Back-calculates flow in MGD from pollutant concentrations and pollutant loadings where concentration is in mg/l and loading is in lbs./day.
- Obtains estimates of pipe flow from one of the following STORET parameter codes: 50050, 00056, 00058, 74060, 82220, 74020, 50049, 78932, 50047, 78720, 73676 (listed in order of preference).
- Computes average daily pollutant loading estimates for the year and summary statistics by pipe (DSCH and PDSG) and monitoring location (MLOC) and assigns associated basis codes.
- Selects the preferred form of the monitoring information to be used based on the following hierarchy: If available, use average mass estimates before maximum mass estimates before average concentration estimates before maximum concentration estimates before minimumconcentration estimates.
- Enters label names for each field element.

PROGRAM G (PROG_G.SAS)
Manipulates the Monitoring File (ST91M_N) and Statistics File (ST_STAT2) to obtain the Daily Load by Month File (ST91MON1) as follows:

- Flags the following cases to delete monitoring pollutant loadings:
  - If coefficient of variation for flow is greater than 95, and the number of observations of flow is greater than two, and flow is greater than one MGD, flag is MF. This results in approximately five to 10 percent of the data being discarded.
  - If coefficient of variation for mass is greater than 133, and the number of observationsof mass is greater than two, flag is MM. This results in approximately 10 percent of the data being discarded.
  - If coefficient of variation for concentration is greater than 157, and the number of observations for concentration is greater than two, flag MC. This results in approximately 10 percent of the data being discarded.

- Subsets the ST91M_N file to include only the following pollutants:

POLLUTANT	STORET CODE
Flow	50050, 00056, 00058, 74060, 82220, 74020, 50049, 78932, 50047, 78720, 73676
BOD, 5-day (20 deg. C)	00310
TSS	00530
Total Arsenic	01002
Total Cadmium	01027
Total Chromium	01034
Total Copper	01042
Total Iron	01045
Total Lead	01051
Total Mercury	71900
Total Zinc	01092

Oil & Grease	00556
Total Nitrogen	00600
Total Phosphorus	00665
Total Fecal Coliform Bacteria	74055
Ammonia,Total (as N)	00610
Nitrogen, Inorganic Total	00640
Nitrogen Kjedhal Total (as N)	00625
Nitrogen, Nitrate Total (as N)	00620
Nitrogen, Nitrite Total (as N)	00615
Organic Total (as N)	00605

- Standardizes units.
- Calculates flows by MLOC and by MONTH in MGD from pollutant concentrations (mg/l) and pollutant mass values (lbs./day) using all sources of data (average, maximum, and minimum).
- Obtains average daily pollutant-loading estimates for the month and assigns associated basis codes.

PROGRAM H (PROG_H.SAS)
Manipulates the Daily Load by Month File (ST91MON1) to obtain the Daily Load by Season File (ST91MON2) as follows:

- Deletes average daily loads for the month if flag for high CV value was assigned.
- Aggregates pollutant loads by MLOC and by SEASON in a pipe.
- Carries along the number of observations of pollutant loading estimates by season.
- Selects monitoring data based on monitoring location. Uses MLOC=2 data (effluent net value) as first choice and MLOC=1 data (effluent gross value) as second choice. **NOTE: Most data are reported in MLOC=1.
- Subsets the ST91MON1 file to carry data only from MLOC=2 or MLOC=1.
- Transposes pollutants, basis codes, and number of observations by season.

- Carries only one flow variable with a basis code under a variable temporarily named PO50050.
- Computes average daily pollutant loading estimates for the year.
- Retains field elements in an established order.

PROGRAM I (PROG_I.SAS)
Manipulates the Permit File (ST91P_N) to obtain the Permit Loads File (ST91PERM) as follows:

- Subsets ST91P_N for same pollutants as Program G.
- Computes average daily pollutant loading estimates for the year.
- Transposes pollutants and basis codes.
- Obtains estimates of pipe flow from one of the following STORET parameter codes: 50050, 00056, 00058, 74060, 82220, 74020, 50049, 78932, 50047, 78720, 73676 (listed in order of preference).
- Carries only one flow variable with a basis code under a variable temporarily named PO50050.
- Carries the following permit data:

    PIPE
    WAST
    PIAC
    TRET
    PLAT
    PLAT1
    PLON
    PLON1

PROGRAM J (PROG_J.SAS)
Manipulates the Permit Application Form File (MID2C) to obtain the Daily Permit Application Loads File (POLL2C) as follows:

- As a first option, uses flow reported in the Intake and "Effluent Characteristics" section of the permit application form. If flow is not reported in this section, the sum of all operation contributing flows reported in the "Flows, Sources of Pollution and Treatment Technologies section of the permit application form is used.
- Adjusts concentration values reported as detection limits to 1/10 the reported value.
- Computes loads using the concentrations and flows reported for each outfall. Adjusts loads for pipes identified as combined pipes (B pipes) using a P-factor assigned to the outfall discharge. If outfall was identified as a cooling water pipe, pollutant loads (except copper) were not computed because effluent discharge pollutant concentrations are gross values instead of net values. A net value is defined as an effluent concentration value subtracted from the intake concentration value. Copper effluent concentration was reduced by 50 percent to approximate the net discharge value for copper.
- Converts the one-digit pollutant basis code entered in the MID2C (Permit Application Form) File into two-digit pollutant basis code.

PROGRAM K (PROG_K.SAS)
Manipulates the Daily Load by Season File (ST91MON2), the Daily Permit Application Loads File (POLL2 C), the Permits Load File (ST91PERM), and the (ST91F) to obtain the Initial Permit/Monitoring/Permit Application

File (STPERMO1). Up to this stage, the entire state has been processed.

PROGRAM L (PROG_L.SAS)
Manipulates the Initial Permit/Monitoring/Permit Application File (STPERMO1) and the Facility File Coastal Counties (CC91ACT) to obtain the Intermediate Permit/Monitoring/Permit Application File (STPERMO2) as follows:

- Subsets the STPERMO1 File to include only facilities in coastal counties.
- Deletes data in records where the variable DSCH contained the value FAC for cases where
- the facility had more than one pipe.
- Deletes any data for BOD, nitrogen (all forms), phosphorus, and FCB where SIC=4911.
- Prints a list of cases in which the variable DSCH contains the value FAC and the facility ha
- only one pipe.
- Obtains listings to check the quality data according to the following conditions in each record:

  If there is only one flow value from all sources and it is greater than one MGD.
  If there is only one BOD or TSS value and it is greater than 10 lbs./day.
  If there is only one value for any of the eight heavy metals included in the inventory.
  If there is only one Oil & Grease value and it is greater than 30 lbs./day.
  If there is only one FCB value and it is greater than 5,000,000 cells/day.

PROGRAM M (PROG_M.SAS)
Edits the Intermediate Permit/Monitoring/Permit Application File (STPERMO2) as follows:

- In cases where the variable DSCH equals FAC and the facility has only one pipe, replaces "FAC" with "001."
- Deletes monitoring, permit, permit application, or design data if determined to be questionable based on best professional judgment.
- Assigns appropriate basis codes to track quality check edits.

PROGRAM N (PROG_N.SAS)
Manipulates the Intermediate Permit/Monitoring/Permit Application File (STPERMO2) to obtain the Final Permit/Monitoring/Permit Application Load File (STPERMON) as follows:

- Replaces missing monitoring data with pollutant loading estimates from POLL2C. Also, if monitoring data are less than 1/10 or greater than two times the permit application data, the permit application form data are used instead of the monitoring data.
- Replaces missing monitoring/permit application data with pollutant-loading estimates from ST91PERM. Also, if monitoring/permit application data are less than 1/100 or greater than two times the permit data, then the permit application form data are used instead of the monitoring/permit application form data.
- Replaces missing monitoring /permit/permit application flows with average design flow (FLOW) from the facilities file. Average design flow (FLOW) was not considered for the following cases:

If facility is MAJOR and SIC code &endash; 4911 and FLOW > 400 or < 0.5 MGD
If facility is MINOR and SIC code &endash; 4911 and FLOW > two MGD
If facility is MAJOR and SIC code = 4911 and DSCH &endash; 001 and FLOW > 1,000 MGD
If facility is MINOR and SIC = 4911 and DSCH &endash; 001 and FLOW > 500 MGD

- Assigns basis codes. A basis code could have a special character attached to it as follows:

  * replaced DMR data because of high flow coefficient of variation
  @ replaced DMR data because of high mass coefficient of variation
  $ replaced DMR data because of high concentration coefficient of variation
  # replaced DMR data because of decision rule
  { replaced DMR data because of questionable flow data
  / replaced DMR data because of questionable mass data
  % replaced DMR data because of questionable concentration data

- Assigns flow type codes, operating days, and P-factors based on permit application information.
- Enters label names for each variable.

PROGRAM O (PROG_O.SAS)
Manipulates the Final Permit/Monitoring/Permit Application Load File (STPERMON), Power Plant File (POWER), Needs 1990, and NCPDI Typical Value Matrix File (REF10 and TPC Matrix) to obtain the Initial TPC File (STFIL5C 1) as follows:

- Assigns flow type codes using WAST (PCS).
- Assigns flow type = C where PIPE reads NONCONTACT COOLING WATER.
- Assigns flow type basis codes.
- Assigns special discharge activity codes (SDAC) and flow type codes to power plants based on
- the POWER data base.
- Assigns flows (where missing) and treatment level to WWTPs based on the Needs Survey data base.
- Replaces flow with flow from Needs Survey if following rules apply:

  If flow x 1.5 < NEEDS Survey flow then use NEEDS Survey Flow
  If flow x 0.5 > NEEDS Survey flow then use NEEDS Survey Flow

- Assigns treatment levels (WWTPs) in the SDAC code using treatment types (TRET).
- Assigns flows (where missing) based on BOD and TSS data for WWTPs.
- Globally assigns flow type codes for WWTP and WSTP as "P."
- Assigns flows (where missing) using typical flows. For minor facilities, typical flows are
- divided by four.
- Assigns flow type codes where FLOWTYPE is missing using the following rules:

If facility is a major facility:

If FLOW is less or equal 2, FLOWTYPE = "P"
If FLOW is greater than 2 and FLOW is less or equal 4, FLOWTYPE = "B"
If FLOW is greater than 4 and FLOW is less or equal 25, FLOWTYPE = "C"
If FLOW is greater than 25, FLOWTYPE = "O"

If facility is a minor facility:
If FLOW is is less or equal 1, FLOWTYPE = "P"
If FLOW is greater than 1 and FLOW is less or equal 2, FLOWTYPE = "B"
If FLOW is greater than 2 and FLOW is less or equal 10, FLOWTYPE = "C"
If FLOW is greater than 10, FLOWTYPE = "O"

- Assigns flow type basis codes.
- Assigns SDAC for residential and commercial facilities.
- Assigns NCPDI discharge category codes by SIC using REF10 data base.
- Assigns SDAC to canned and preserved seafood producers.
- Assigns SDAC to canned fruit and vegetables facilities.
- Assigns SDAC to WSTPs.
- Assigns SDAC to power plants if SDAC is missing.
- Assigns secondary treatment levels to WWTPs (SDAC code) if treatment level is still missing.
- Assigns operating days based on discharge category code from REF10. Any facility not covered by REF10 is assumed to operate 365 days per year.
- Assigns operating days source code.
- Assigns operating days as 63 where flow type = "O" and operating days is missing.
- Assigns P-factors.
- Assigns typical pollutant concentrations (TPC). TPC for tertiary WWTPs are half the value of secondary WWTPs.
- Assigns seasonal coefficients.
- Produces listings to check for cases where there might be a misassignment of flow types (i.e., high flow rates with P pipes).

PROGRAM P (PROG_P.SAS)
Manipulates the Initial TPC File (STFIL5C1) to obtain the Intermediate TPC File (STFIL5C2) as follows:

- Corrects misassignments of flow types based on review of list produced in Program O.

PROGRAM Q (PROG_Q.SAS)
Creates File V - Final TPC Seasonal Loads File

Manipulates the Intermediate TPC File (STFIL5C2) to obtain the Final TPC Seasonal Loads File (STFILE5) as follows:

- Computes seasonal flow and pollutant loading estimates for each season (refer to Table 5 in Section 3).
- Assigns pollutant basis codes indicating that estimates for this file are based only on typical pollutant concentrations.
- Enters labels for each field element.

PROGRAM R (PROG_R.SAS)
*Creates File VI - Pipe Level Loadings File*Manipulates the Final Permit/Monitoring/Permit Application Load File (STPERMON) and the Final TPC Seasonal Loads File (STFILE5) to obtain the Pipe-Level Loadings File (STFILE6) as follows:

- Computes seasonal loads from monitoring (DMR), permit, and permit application data (see Table 5 for general equations).
- Fills missing pollutant-loading data with loadings from information in File 5.
- Computes annual pollutant loadings by summing seasonal estimates.
- Deletes pollutant loading estimates and basis codes where the variable PIAC = I (indicates an inactive pipe) or the variable DSCH=INT (indicates an intake pipe).
- Deletes pollutant-loading estimates and basis codes (except copper estimates) where the variable SIC=4911 (power plants) and the variable FLOWTYPE=C (once-through cooling discharge).
- Creates a series of variables containing the short form of the pollutant basis code to be incorporated in STFILE7.
- Organizes the field elements in the data base.
- Enters label names for all field elements.

PROGRAM S (PROG_S.SAS)
Manipulates the Pipe Level Loadings File (STFILE6) as follows:

- Obtains listings of pollutants for pipes with 100 largest flows (in descending order) to identify questionable data to correct and rerun programs.
- Prints ranked order listing of pipes with the 100 largest flows and the 50 largest pollutant discharges for each state. Unacceptable estimates are identified based on best professional judgment, replaced with the next best alternative, and programs rerun starting with Program M or Program P.

PROGRAM T (PROG_T.SAS)
Creates File VII - Facility-Level Loadings File

Manipulates the Pipe Level Loadings File (STFILE6) and Facility File Coastal Counties (CC91ACT) to obtain the Facility-Level Loadings File (STFILE7) as follows:

- Aggregates seasonal and annual pipe-level loading estimates to the facility level and carries over the short form of the pollutant basis code from File 6.
- Adds several field elements from CC91ACT.
- Organizes the field in the data base.
- Enters label names for all field elements.

PROGRAM U (PROG_U.SAS)
Manipulates the facility level loadings file (STFILE7) as follows:

- Obtains listings of pollutants for facilities with the 100 largest flows (in descending order) to identify questionable data to correct and rerun programs.

- Prints a ranked order listing of pipes with the 50 largest pollutant discharges for each state. Unacceptable estimates are identified based on best professional judgment, replaced with the next best alternative, and programs are rerun starting with Program M or Program P.

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General Equations Used to Estimate Loadings

Used when Flow Type is Process, Cooling, Recycled or Sanitary

Seasonal Load = daily flow (for the year) x pollutant concentration x operating days per year x seasonality factor (usually 0.25)

(lbs/season) = (MG/days) year x (mg/l) x (days/year) x (year/season)

Used when Flow Type is Combined (process and cooling, sanitary and cooling, sanitary and stormwater runoff or process and stormwater runoff)

$\text{Seasonal Load}_{\text{combined}} = \text{Seasonal Load}_{\text{process or sanitary}} + \text{Seasonal Load}_{\text{cooling or stormwater}}$

$\text{Seasonal Load}_{\text{process or sanitary}}$ = daily flow (for the year) x pollutant concentration x operating days per year x seasonality factor (usually 0.25) x % process water ("P" factor)

$\text{Seasonal Load}_{\text{cooling or stormwater}}$ = daily flow (for the year) x pollutant concentration for cooling or storm water x operating days per year x seasonality factor (usually 0.25) x (1-"P" factor)

(lbs/season) = (MG/days) year x (mg/l) x (days/year) x (year/season) x process factor

Gulf of Mexico Land-Based Pollution Sources Inventory

Pollutant Basis Codes - Short Description
(ex: FLOWCODE, BODCODE, ASCODE, etc.)

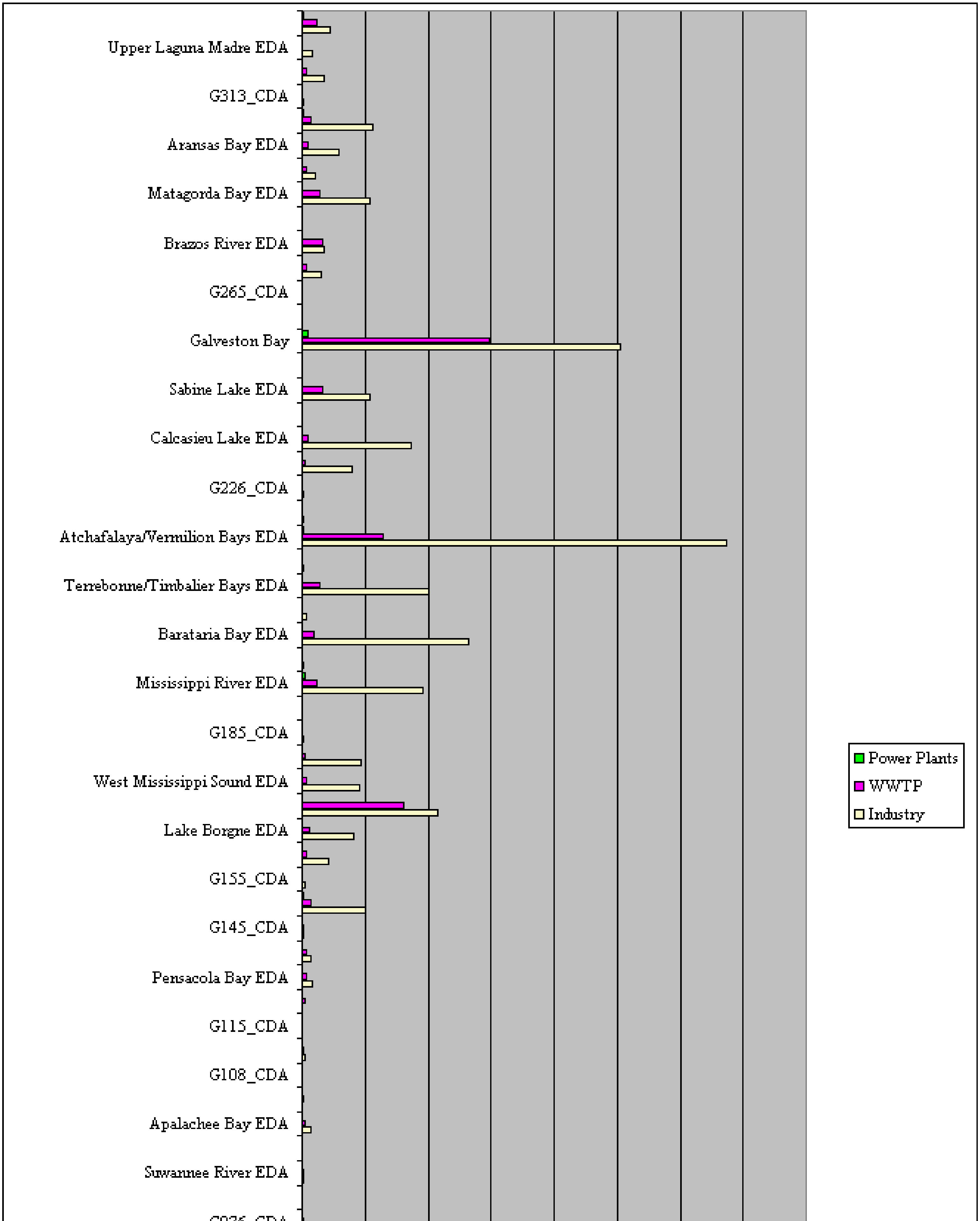
This code documents in short format the basis of pollutant-loading estimates:

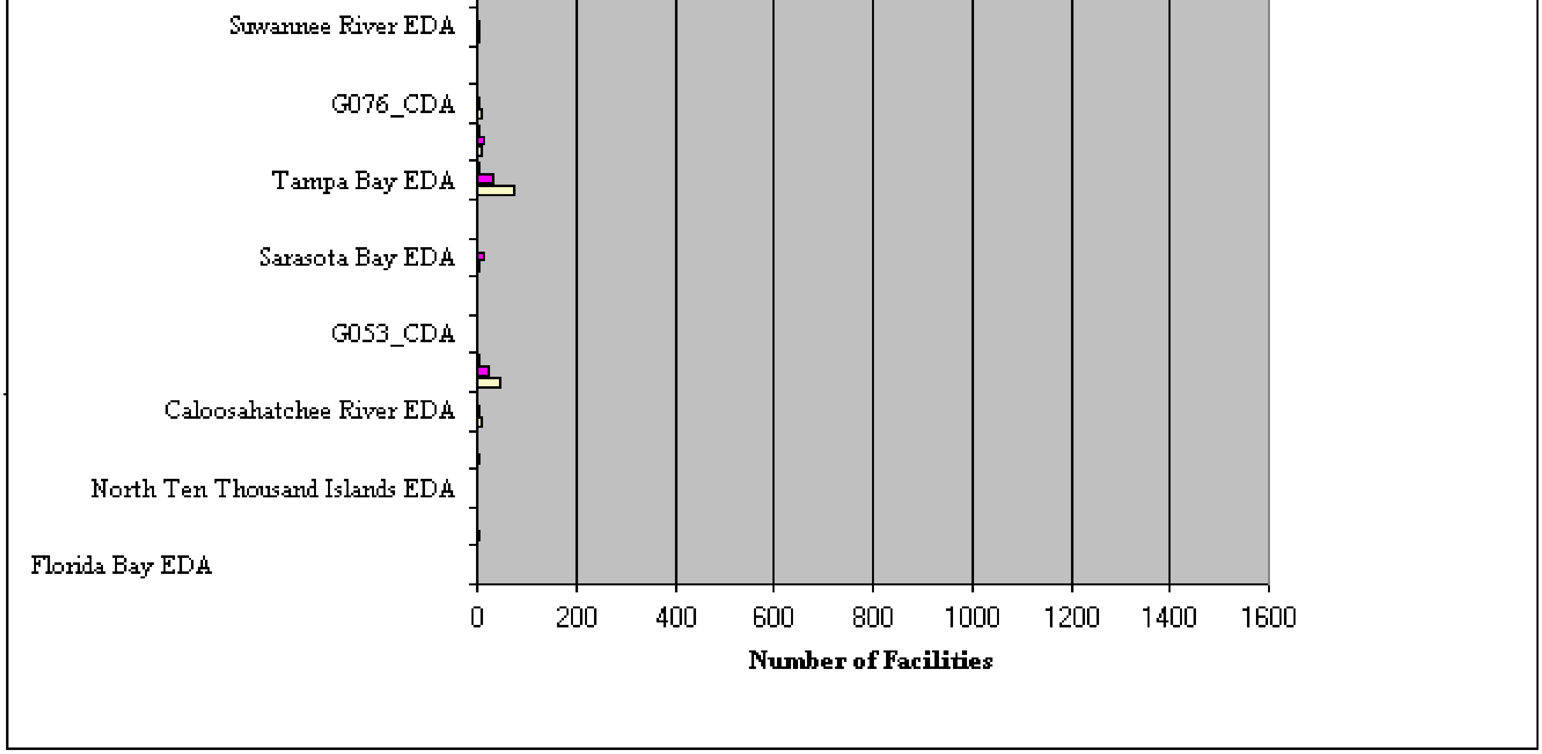
Code	Description
M	Monitoring data
P	Permit data
T	Typical pollutant concentration data
O	Other data
B	Combination of the above

- Click here to obtain more detailed information on basis codes.

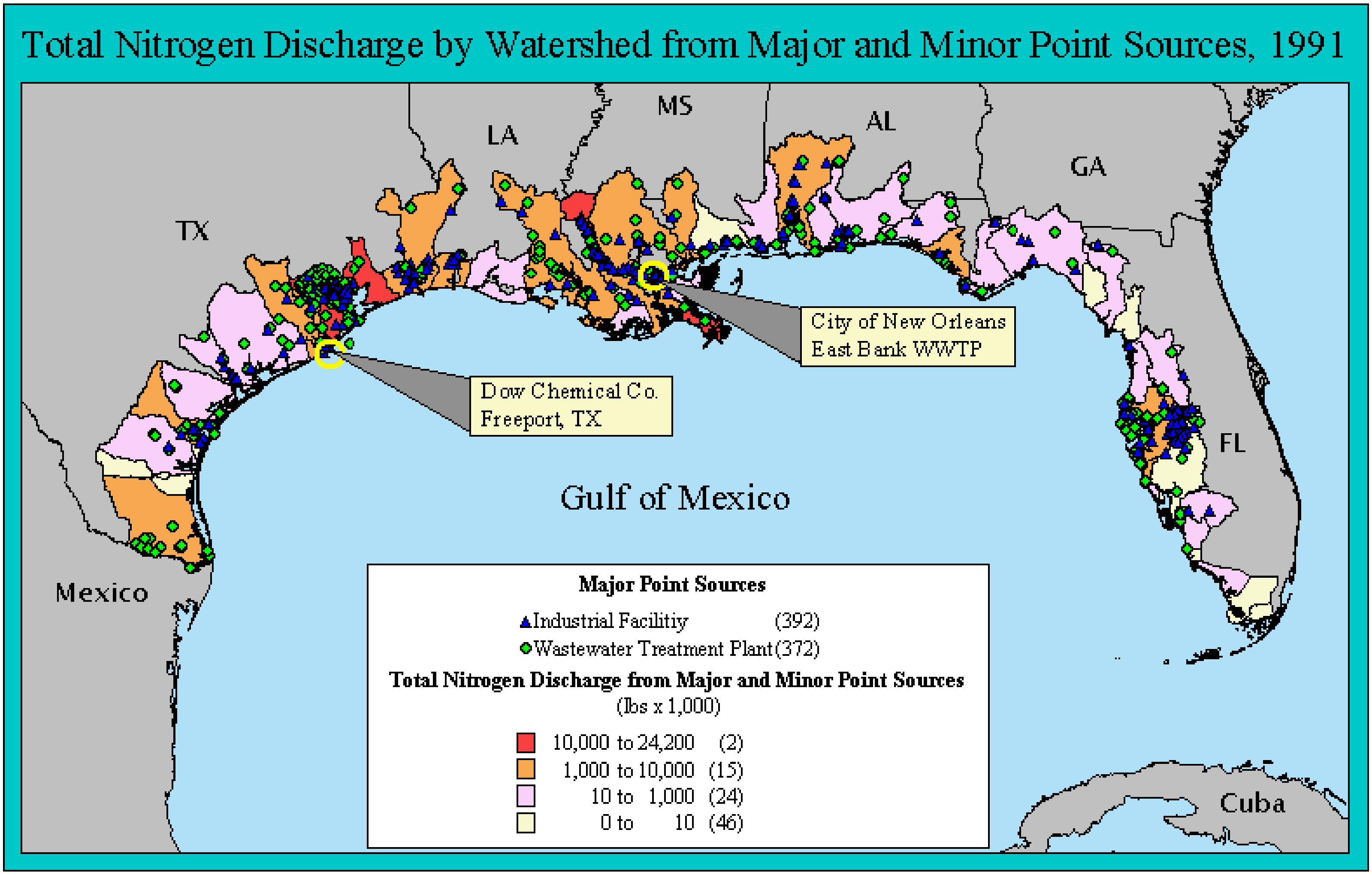
Return to Point Sources

Number of Point Source Facilities by Watershed and Major Point Source Category in the Gulf of Mexico Study Area, 1991

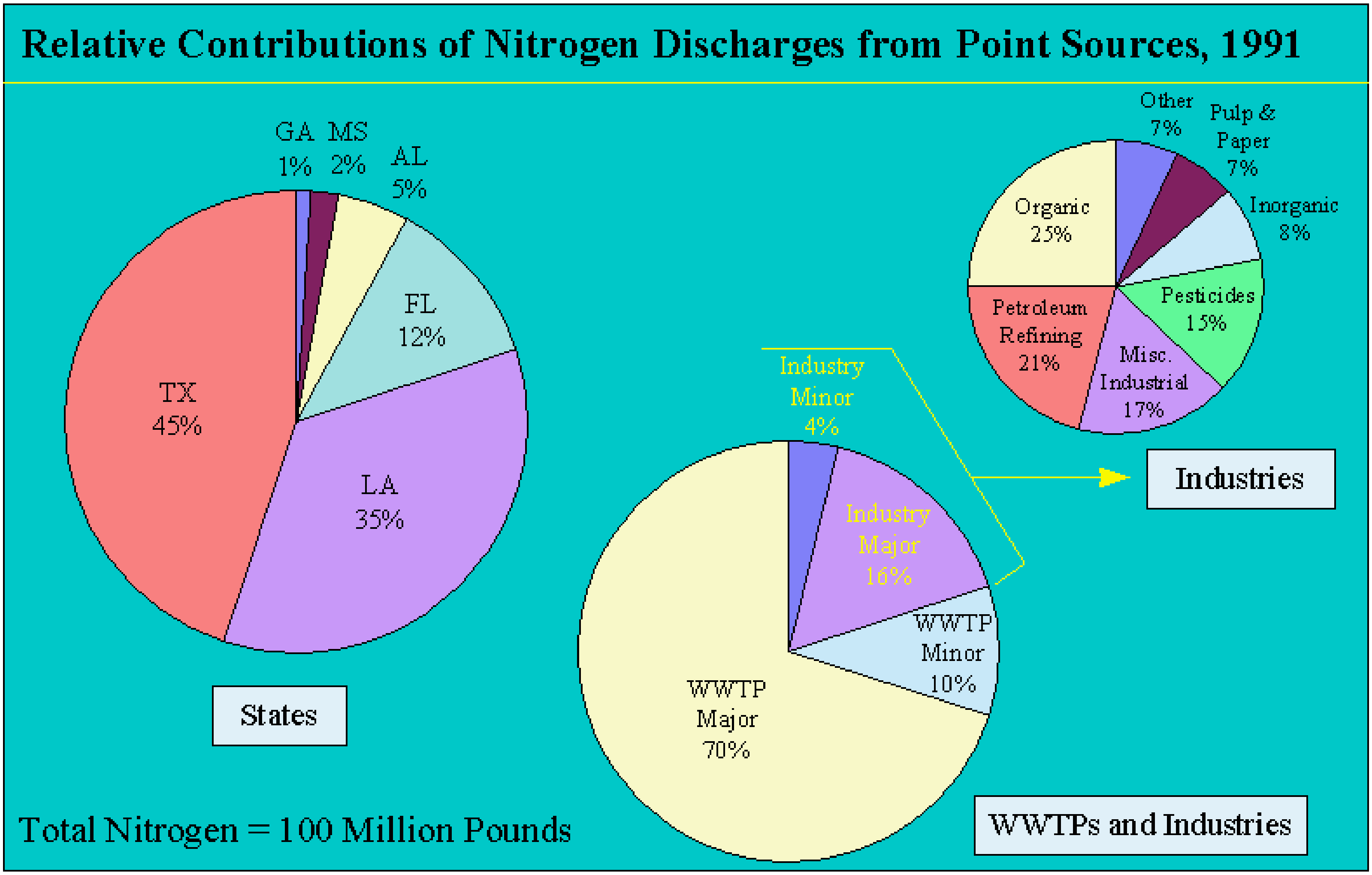


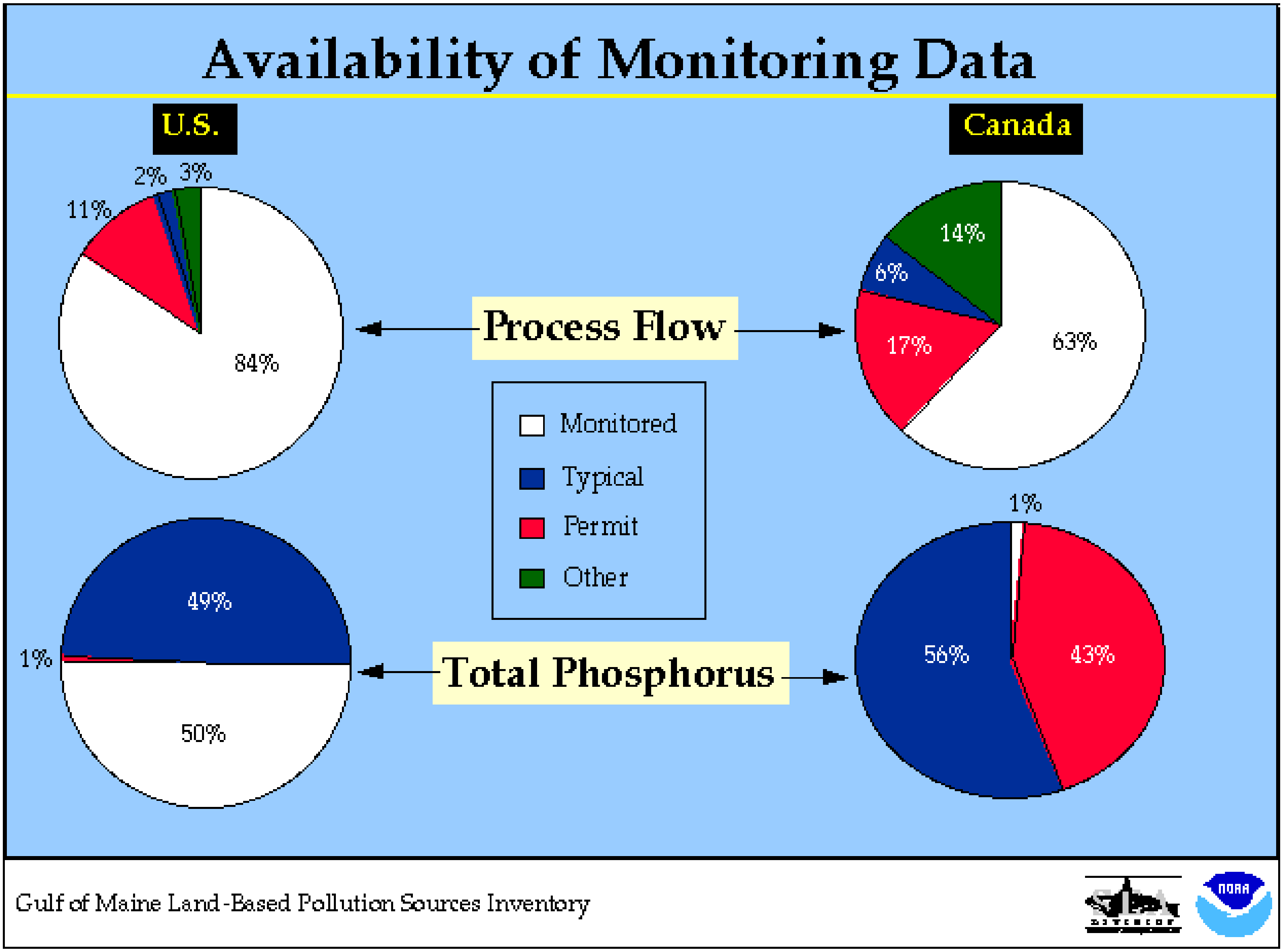

Suwannee River EDA
G076_CDA
Tampa Bay EDA
Sarasota Bay EDA
G053_CDA
Caloosahatchee River EDA
North Ten Thousand Islands EDA
Florida Bay EDA
0
200
400
600
800
1000
1200
1400
1600
Number of Facilities

Gulf of Mexico Land-Based Pollution Sources Inventory



NOTE: The top industrial discharger of nitrogen and the top wastewater treatment plant discharger of nitrogen are highlighted.

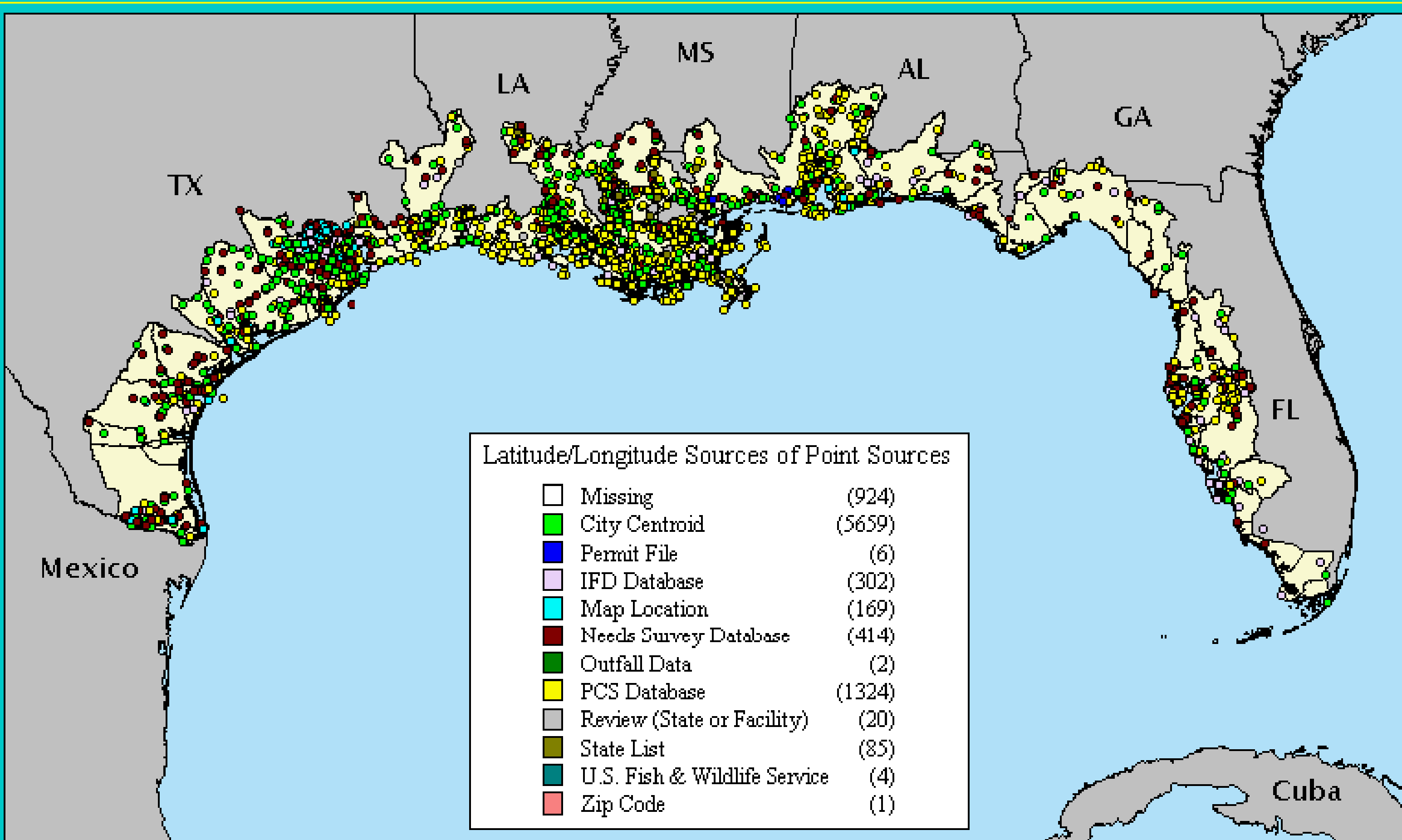

Relative Contributions of Nitrogen Discharges from Point Sources, 1991
GA 1%
MS 2%
AL 5%
FL 12%
LA 35%
TX 45%
States
Total Nitrogen = 100 Million Pounds
Industry Minor 4%
Industry Major 16%
WWTP Minor 10%
WWTP Major 70%
WWTPs and Industries
Other 7%
Pulp & Paper 7%
Inorganic 8%
Pesticides 15%
Misc. Industrial 17%
Petroleum Refining 21%
Organic 25%
Industries



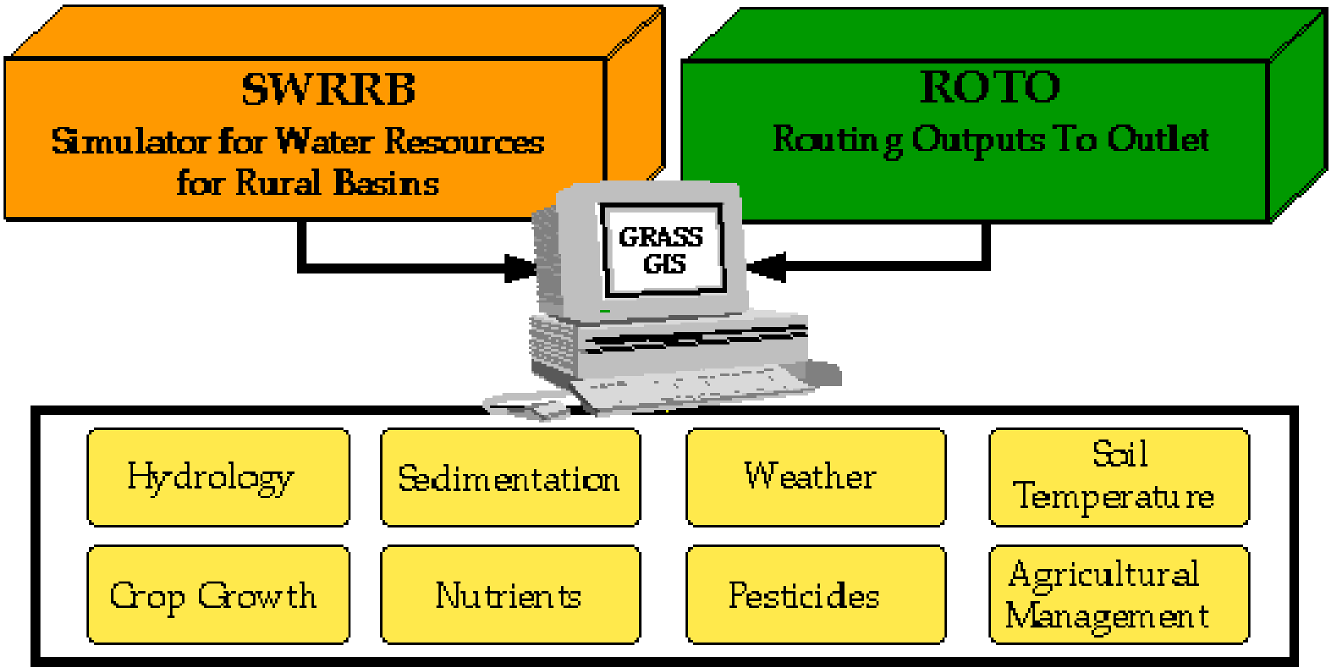
Availability of Monitoring Data
U.S.
Canada
2%
3%
11%
84%
14%
6%
17%
63%
Process Flow
Monitored
Typical
Permit
Other
49%
1%
50%
1%
56%
43%
Total Phosphorus
Gulf of Maine Land-Based Pollution Sources Inventory

Gulf of Mexico Land-Based Pollution Sources Inventory

Latitude/Longitude Sources

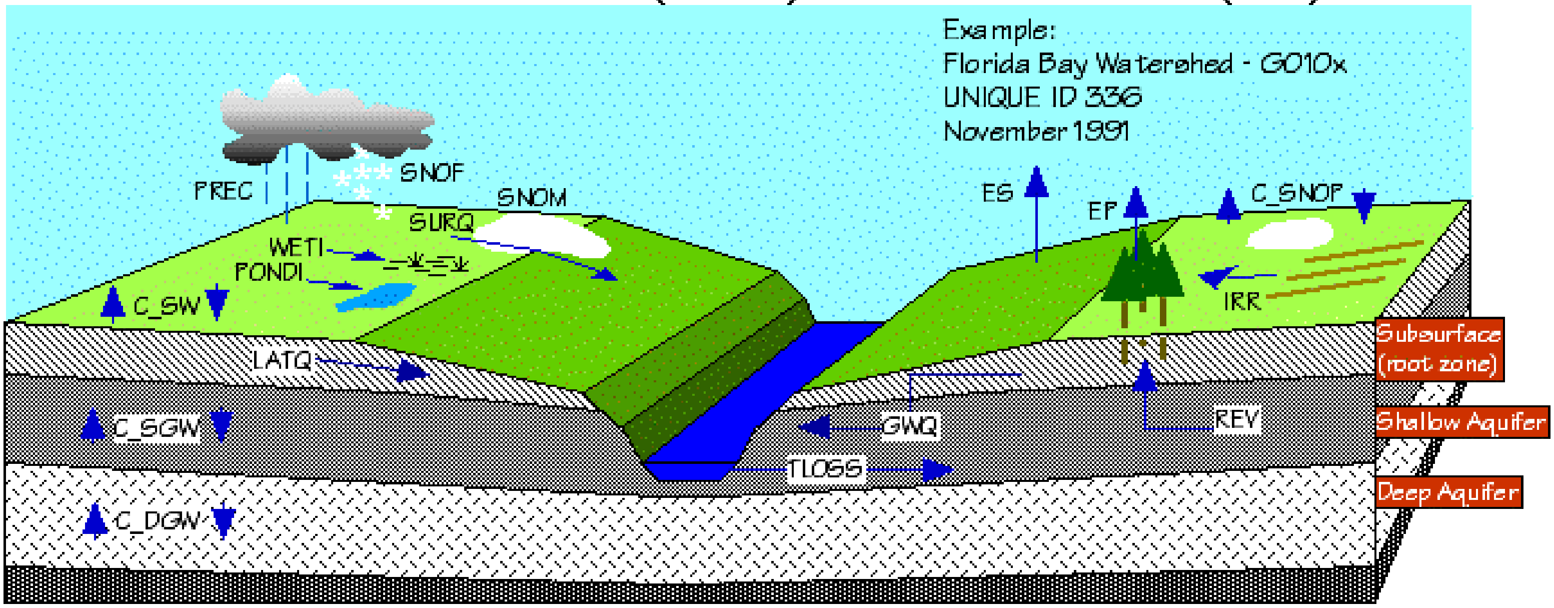


Nonpoint Source Model



NOTE: Load Estimates for 19 Urban and Non-Urban Land Uses

Soil and Water Assessment Tool (SWAT) Water Mass Balance (mm)



Inputs | Outputs

PREC + SNOF + IRR = SURQ + SNOM + LATQ + GWQ + ES + EP + REV + TLOSS + C_SGW + C_DGW + C_SW + C_SNOP - PONDI - WETI

603 mm ≅ 603 mm

Inputs

Precipitation (Rainfall)	603	(PREC)
Snow Fall	0	(SNOF)
Irrigation Application	0	(IRR)

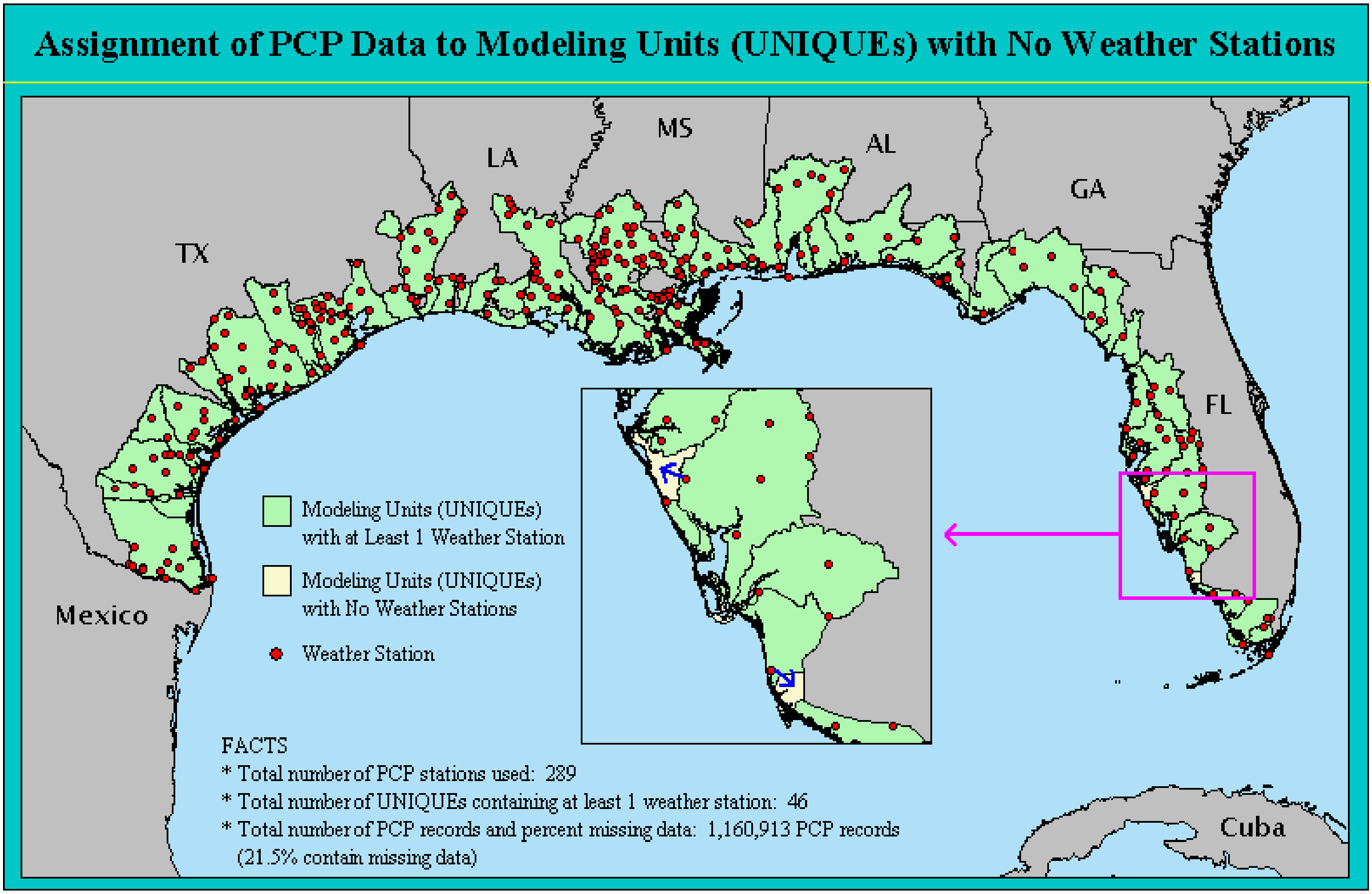
Outputs

Surface Runoff	17	(SURQ)	Transmission Losses	0	(TLOSS)
Snow Melt	0	(SNOM)	Change in Shallow Groundwater Storage	0	(C_SGW)
Lateral Flow	1	(LATQ)	Change in Deep Groundwater Storage	10	(C_DGW)
Ground Water	166	(GWQ)	Change in Soil Water Content	-14	(C_SW)
Evaporation from Soils	377	(ES)	Change in Snow Pack	0	(C_SNOP)
Evaporation from Plants	0	(EP)	Flow Lost to Ponds	0	(PONDI)
Revaporation	46	(REV)	Flow Lost to Wetlands	0	(WETI)

Imperviousness by Urban Land Use

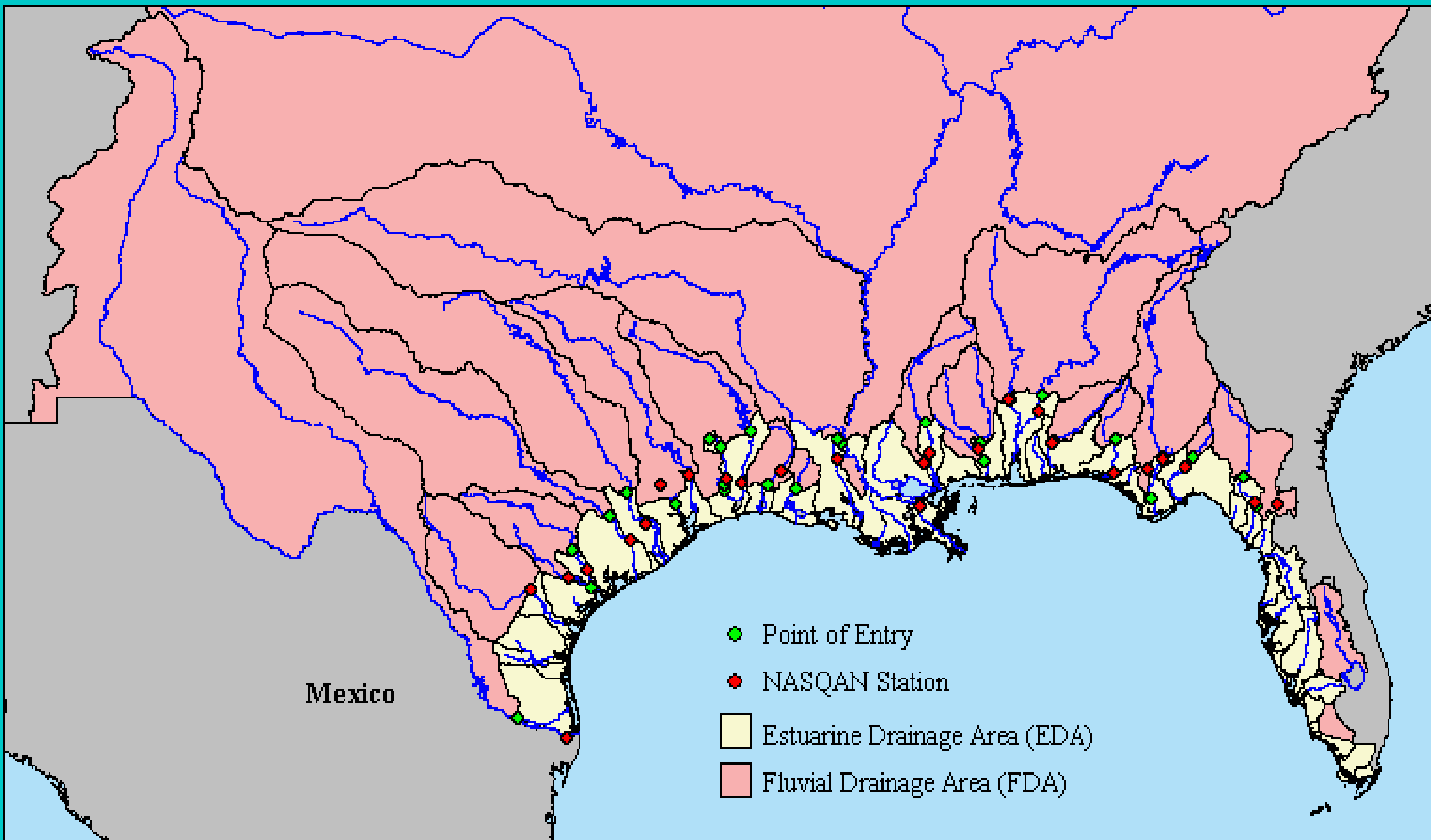
Land Use	Imperviousness
Residential	0.34
Commercial	0.99
Industrial	0.64
Non-urban	0.06
Mixed	0.48

Gulf of Mexico Land-Based Pollution Sources Inventory



Gulf of Mexico Land-Based Pollution Sources Inventory

Upstream Sources Point of Entry to Study Area (Estuarine Drainage Area [EDA])



Nonpoint Source Files

INPUT FILES

A) Modeling Unit (unique) Level Data

Weather

1) GU_WEA

This file contains daily precipitation (mm) and daily high and low temperatures (degrees Centigrade) for weather stations in the study area. Period range is from 1989-1995. The file has modeling unit (unique), huc, and eda/cda codes associated to each weather station.

2) GUAVGWEA

This file contains an average of daily precipitation (mm) and daily high and low temperatures (degress Centigrade) of ALL weather stations in the modeling unit (unique).

3) GUMONWEA

This file contains monthly average precipitation (mm) and monthly high and low temperatures (degrees Centigrades) of All weather stations in the modeling unit (unique).

4) GUSTA_ID

This file contains general locational information about the weather station.

Point Sources

5) GU_POINT

This file contains NOAA's pollutant monthly loading estimates of point sources by modeling unit (unique).

Reservoirs

6) GU_POND

This file contains reservoir's average information by modeling unit (unique). Source is the National Inventory of Dams (NID) database.

USGS Stream Gauge

7) GU_GAUGE

This file contains USGS Gauge Station daily flows in cubic meters per second for a period of 1989-1995.

8) GUGAU_ID

This file contains locational data about the USGS Gauge Station.

Land Use

9) GU_LUSE

This file contains areas and percentages of landuses in the modeling unit (unique). Source is USGS LUDA data circa 1970 improved by using Census 1990 information to better characterize urban areas of present conditions.

10) GU_LUSOI

This file contains landuse percentages and soil names in each modeling unit (unique).

Routing

11) GU_ROUT

This file provides the modeling unit (unique) routing scheme. It also provides drainage areas of uniques.

12) GU_RTE

This file contains information on channel dimensions (length, slope, wirdth, depth, etc) for the main channel through the modeling unit (unique).

Others

13) GUCTYSUB

This file contains the percentage area of the modeling unit (unique) that exists in the county.

14) GU_GW

This file contains aquifer data including recession parameter, specific yield, revaporation and deep aquifer percolation coefficients.

Look Up Files

15) GU_CROP

This file contains general crop information. When a crop is specified to be planted in the management (mgt) file, the crop parameters for that crop are taken from this file (crop.dat). The crop parameters include biomass conversion factopr, harvest index, optimum and base temperature, maximum leaf area, maximum root depth and severla others.

16) GU_PEST

This file contains general information on pesticides. Pesticide parameters that can be selected in the management (mgt) file include the soil partition coefficient, washoff fraction, foliar and ground half-lives, and water solubilities.

17) GU_TILL

This file contains general information on tillage. It contains mixing efficiencies for several tillage operations that are selected in the managament (mgt) file.

18) GU_FERT

This file contains general information on fertilizer application rates in kg/ha.

19) GU_WGN

This file contains information on weather generator information used in the model run. It contains monthly parameters that are required for generating amounts of precipitation, maximun and minumum temperatures, and solar radiation. Many of the parameters are required by the model even if measure precipitation and temperature are used.

20) GU_COD

This file contains the number of years of simulation, beginning year, print codes, weather gneration control codes, and several others. All the inputs are common to the entire basin and are not modeling unit (unique) dependent.

B) Virtual Basin (landuse/crop) Level Data

21) GU_MCO

This file contains data for automatic management operations for irrigation and fertilization. While stress level is input to trigger irrigation or fertilization, SWAT automatically boost soil levels to specified amounts.

22) GU_MGT

This file contains data for management operations for planting, harvest, irrigation applications, nutrient applications, pesticide applications, and tillage operations. Operations can be scheduled by month and day or by heat units. The maximum number of years of rotation is currently set at 40, however it can be easily increased.

23) GU_SOL

This file contains soil data including bulk density, available water capacity, saturated conductivity, particle sizes, organic carbon, and maximum rooting depth for each virtual basin in the modeling unit (unique). Each soil can have a maximum of 10 soil layers. Sequential number is already selected.

24) GU_SUB

This file contains general inputs specific to each modeling unit (unique) that include area, curve number, land and channel slopes and lengths, USLE P factor, and initial residue cover.

OUTPUT FILES

1) GU_SBS

This file contains 1989-1995 nonpoint source monthly pollutant loading estimates and other data related to water, sediment, nutrients, and crops for each virtual basin (landuse) in each modeling unit (unique). It has over 120 variables

2) GU_BSB

This file contains 1989-1995 nonpoint source monthly pollutant loading estimates and other data related to water, sediment, nutrients, and crops for each modeling unit (unique). It has over 60 variables.

3) GU_RCH

This file reports 1989-1995 monthly output for each stream channel routing reach in each modeling unit (unique). Output variables include water, sediment, and pollutants entering and leaving the reach.

4) GU_STD.ASC

This is the standard old Simulator for Water Resources of Rural Basins (SWRRB) model output file described in the "SWRRB book" - Arnold, Williams, Nicks, and Sammons, 1990, Texas A & M Press. This file is not part of NOAA's SAS database management system, consequently, it is not linked to all other input and output files.

Total Nitrogen Yield (TN) (lbs/acre/yr)

Land Use	SWAT Range	Literature	Source	%	Comment
Crop Land		*0.1 - 1.2*	*(15)*		
		0.09 - 11.6	*(16)*		
Crop Land	=0			5.4	okay
Crop Land	> 0 - 0.1			36.0	okay
Crop Land	> 0.1 - 12			58.6	okay
Crop Land	>12			0.0	
Forest Land		*2.7 - 12*	*(15)*		
		2.68 - 11.6	*(16)*		
Forest Land	=0			21.8	okay
Forest Land	> 0 - 2			78.0	okay
Forest Land	> 2 - 12			0.2	okay
Forest Land	> 12			0.0	
Urban		*6.4 - 8.9*	*(15)*		
		6.2 - 8.0	*(16)*		
Urban	> 0 - 1			23.6	okay
Urban	> 1 - 6			41.0	okay
Urban	> 6 - 9			0.2	okay
Urban	> 9			0.0	
Range Land		*Not Known*			
Range Land	=0			15.2	
Range Land	> 0 - 1			81.9	
Range Land	> 1 - 6			2.9	
Range Land	> 6			0.0	

Total Phosphorus Yield (TP) (lbs/acre/yr)

Land Use	SWAT Range	Literature	Source	%	Comment
Crop Land		*0.05 - 2.7*	*(15)*		
		0.05 - 2.59	*(16)*		
Crop Land	=0			15.4	okay
Crop Land	> 0 - 0.05			81.3	okay
Crop Land	> 0.05 - 3			4.2	okay
Crop Land	>3			0.0	
Forest Land		*0.03 - 0.8*	*(15)*		
		0.03 - 0.8	*(16)*		
		0.22	*(17)*		
Forest Land	=0			90.0	okay
Forest Land	> 0 - 0.03			10.0	okay
Forest Land	> 0.03 - 1			0.0	okay
Forest Land	> 1			0.0	
Urban		*1.1 - 5.4*	*(15)*		
		0.98 - 5.0	*(16)*		
		0.41	*(17)*		
Urban	=0			16.1	okay
Urban	> 0 - 0.5			75.9	okay
Urban	> 0.05 - 6			8.0	okay
Urban	> 6			0.0	
Range Land		*0.07 - 0.08*	*(15)*		
		0.07	*(16)*		
		0.06	*(17)*		
Range Land	=0			54.1	okay

Range Land	> 0 - 0.05			41.6	okay
Range Land	> 0.05 - 0.08			1.4	okay
Range Land	> 0.08			2.2	

Total Suspended Solids (TSS) Yield (lbs/acre/yr)

Land Use	SWAT Range	Literature	Source	%	Comment
Crop Land		*Unknown*			
Crop Land	=0			5.4	
Crop Land	> 0 - 1			17.1	
Crop Land	> 1 - 10			22.8	
Crop Land	> 10 - 100			35.7	
Crop Land	> 100 - 1000			13.4	
Crop Land	> 1000 - 5000			1.3	
Crop Land	> 5000			0.0	
Forest Land		*106.8*	*(17)*		
Forest Land	=0			54.0	okay
Forest Land	> 0 - 50			44.7	okay
Forest Land	> 50 - 150			1.0	okay
Forest Land	> 150 - 500			0.3	
Forest Land	> 500			0.0	
Urban		*79.2*	*(17)*		
Urban	=0			9.2	okay
Urban	> 0 - 50			60.9	okay
Urban	> 50 - 100			13.7	okay
Urban	> 100			16.2	
Range Land		*113.7*	*(17)*		
Range Land	=0			28.7	okay
Range Land	> 0 - 100			58.0	okay
Range Land	> 100 - 150			2.1	okay
Range Land	> 150			11.3	

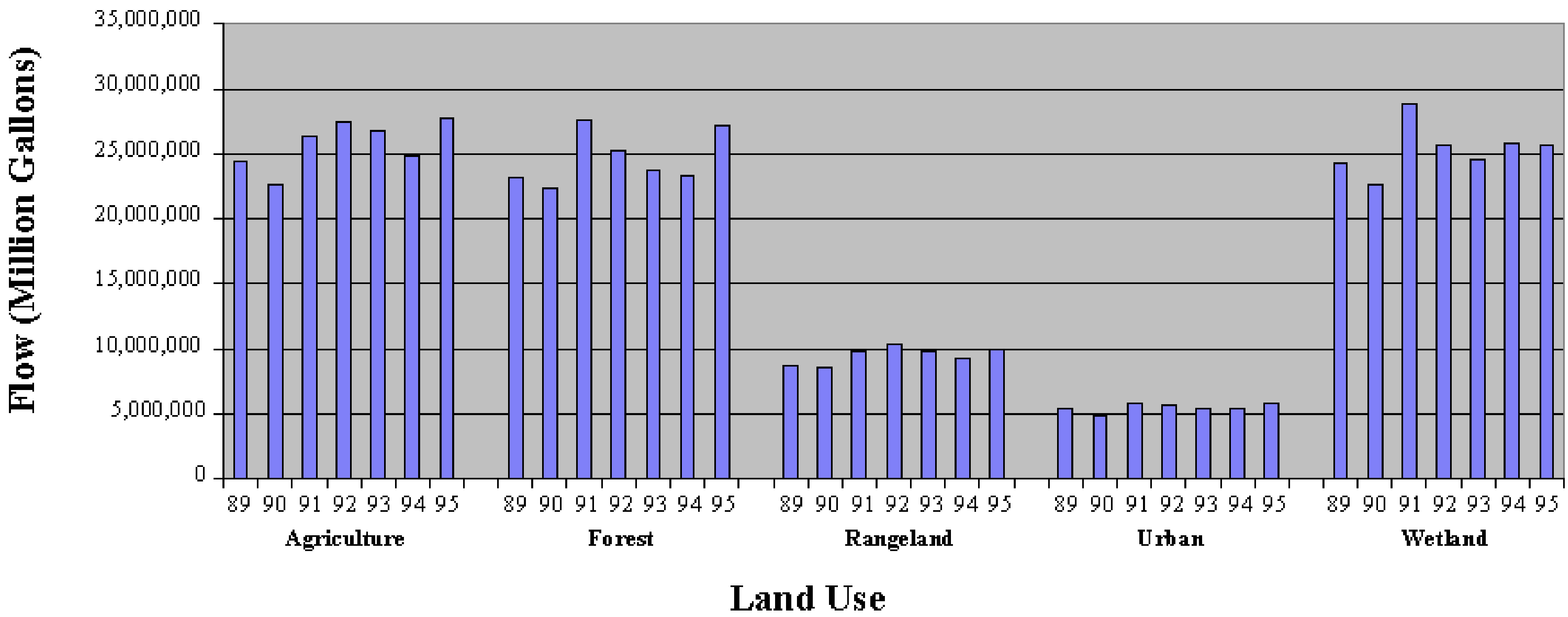
Nonpoint Source Pollutant Concentrations in Reaches from SWAT and Literature (mg/L)

Ammonium and Organic Nitrogen (mg/L)				
SWAT Range	**Literature**	**Source**	**%**	**Comment**
	0.3 - 12.4	*(18)*		
> 0 - 0.1			78.6	okay
> 0.1 - 13			17.7	okay
> 13			0.0	
Flow ne 0 & Conc. eq 0			2.6	
Flow eq 0 & Conc. ne 0*			0.6	
Flow eq 0 & Conc. Eq 0			0.5	
Nitrite_N and Nitrate-N (mg/L)				
SWAT Range	**Literature**	**Source**	**%**	**Comment**
	0.06 - 5.2	*(18)*		
=0			0.1	okay
> 0 - 0.05			56.1	okay
> 0.05 - 5.5			38.3	okay
> 5.5			3.5	
Flow ne 0 & Conc. eq 0			0.8	
Flow eq 0 & Conc. ne 0*			0.8	
Flow eq 0 & Conc. Eq 0			0.4	
Total Phosphorus (mg/L)				
SWAT Range	**Literature**	**Source**	**%**	**Comment**

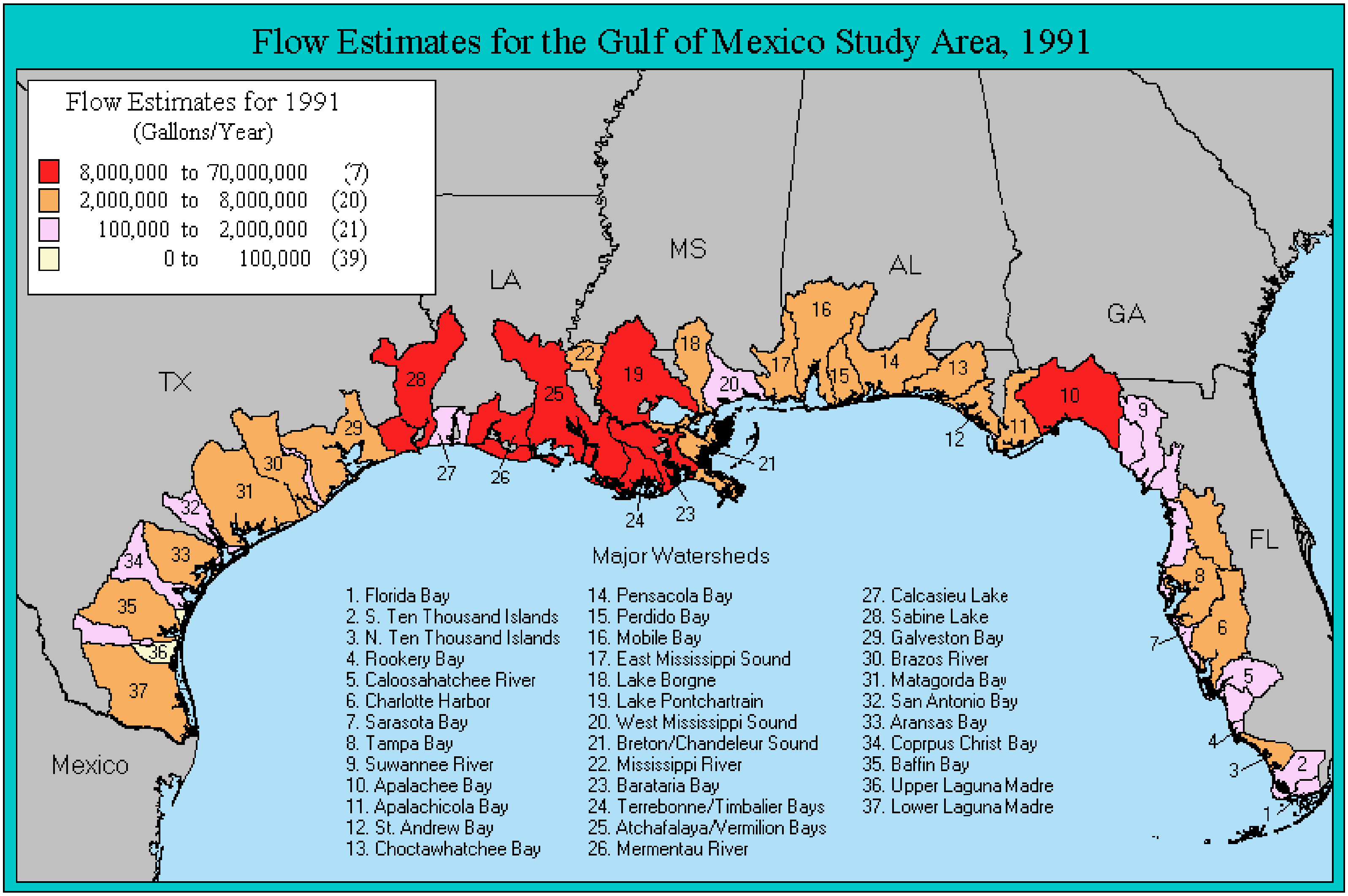
	0.01 - 6.4	*(18)*		
> 0 - 0.01			66.2	okay
> 0.01 - 6.5			30.7	okay
> 6.5			2.0	
Flow ne 0 & Conc. eq 0			0.0	
Flow eq 0 & Conc. ne 0*			0.3	
Flow eq 0 & Conc. Eq 0			0.8	
Total Suspended Solids (TSS) (mg/L)				
SWAT Range	**Literature**	**Source**	**%**	**Comment**
	1 - 1,910	*(18)*		
> 0 - 1			64.0	okay
> 1 - 2000			28.9	okay
> 2000			0.6	
Flow ne 0 & Conc. eq 0			5.4	
Flow eq 0 & Conc. ne 0*			0.6	
Flow eq 0 & Conc. Eq 0			0.5	

** Due to Point Source Input to Streams, and Sub-daily Time Steps of QUAL-2E Routing*

Flow Estimates in the Gulf of Mexico Study Area by Land Use, 1989-1995



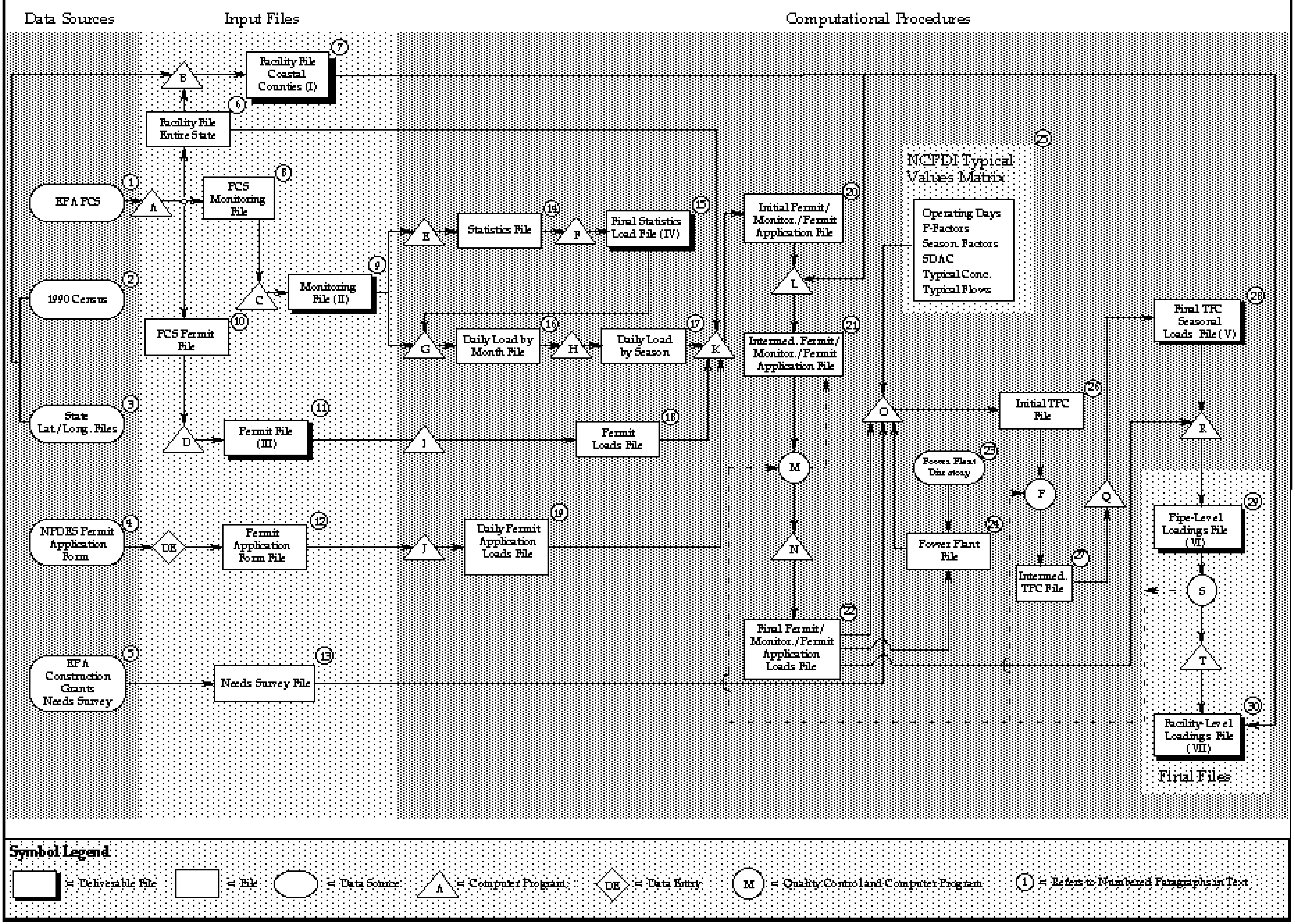
[Next Parameter](#)



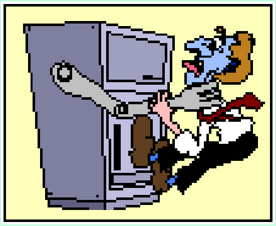
Note: Flow (total) is the sum of surface flow, lateral flow and groundwater flow

Next Parameter

General Pollutant Loadings Estimation Schematic



Gulf of Mexico Land-Based Pollution Sources Inventory



Pollutant Basis Codes - Detailed Description

e.g., LOADBASE, BAS00310, BAS00530, BODBASE etc. (3 characters)

This code documents, in detail, the basis of how pollutant-loading estimates were made.

Basis Code Description:

- **Mass Data**
  1A - Average DMR quantity value from PCS data base
  1B - Maximum DMR quantity value from PCS data base
  1C - Average DMR value from State files
  1D - Maximum DMR quantity value from State files
  1E - Average DMR quantity value - Review process
  1F - Maximum DMR quantity value - Review process

- **Form 2C (Permit Application Form)**
  2C - Long-term average from permit application form
  2B - Maximum 30 day from permit application form
  2A - Maximum daily from permit application form
  2Z - Laboratory report from permit application form
  2H - No value (zero), test required from permit application form
  2I - No value (zero), believed present from permit application form
  2J - No value (zero), believed absent from permit application form
  2K - Not detected (zero), test required from permit application form
  2L - Not detected (zero), believed present from permit application form
  2M - Not detected (zero), believed absent from permit application form
  2N - Not detected (zero), not applicable from permit application form
  2O - Detection limits, test required from permit application form
  2P - Detection limits, believed present frompermit application form
  2Q - Detection limits, believed absent from permit application form
  2Y - Detection limits, laboratory report from permit application form
  2T - Trace (zero) from permit application form
  2X - Other statements (zero) from permit application form
  2G - Average 30 days (pH) from permit application form
  2F - Average daily (pH) from permit application form
  2E - Minimum 30 days (pH) from permit application form
  2D - Minimum daily (pH) from permit application form
  2V - Average flow from sum of all operations (internal pipes)
  22 - Annual average value frompermit application form-WWTP
  23 - Lowest monthly average from permit application form-WWTP

24 - Highest monthly average from permit application form-WWTP

- **Other Data**

3A	Actual average value obtained from Needs Survey data base
3B	Present design value obtained from Needs Survey data base
3C	Value from IFD data base
3D	Load from permit load average value from PCS data base
3E	Load from permit load maximum value from PCS data base
3F	Load from permit concentration average value and flow average from PCS data base
3G	Load from permit concentration maximum value and flow average from PCS data base
3H	Load from permit concentration minimum value and flow average from PCS data base
3I	Load from permit concentration average value and flow maximum or minimum from PCS data base
3J	Load from permit concentration maximum value and flow maximum or minimum from PCS data base
3K	Load from permit concentration minimum value and flow maximum or minimum from PCS data base
3L	Data from old NCPDI file (1982)
3M	Data from old NCPDI file (1987)
3N	Data from old NCPDI file (1990)
3O	Other sources of monitoring data (for listing of sources contact the NCPDI)

- **Monitored Data**

4A	Load from average flow and concentration reported in the MQAV field in PCS data base
4B	Load from average flow and concentration reported in the MCAV field in PCS data base
4C	Load from average flow and concentration reported in the MQMX field in PCS data base
4D	Load from average flow and concentration reported in the MCMX field in PCS data base
4E	Load from average flow and concentration reported in the MCMN field in PCS data base
4F	Load from maximum or minimum flow and concentration reported in the MQAV field in PCS data base
4G	Load from maximum or minimum flow and concentration reported in the MCAV field in PCS data base
4H	Load from maximum or minimum flow and concentration reported in the MQMX field in PCS data base

4I	Load from maximum or minimum flow and concentration reported in the MCMX field in PCS data base
4J	Load from maximum or minimum flow and concentration reported in the MCMN field in PCS data base
4K	Load from average flow (computed from concentration and load values) and concentration reported in the MQAV field in PCS data base
4L	Load from average flow (computed from concentration and load values) and concentration reported in the MCAV field in PCS data base
4M	Load from average flow (computed from concentration and load values) and concentration reported in the MQMX field in PCS data base
4N	Load from average flow (computed from concentration and load values) and concentration reported in the MCMX field in PCS data base
4O	Load from average flow (computed from concentration and load values) and concentration reported in the MCMN field in PCS data base
4P	Load from maximum flow (computed from concentration and load values) and concentration reported in the MQAV field in PCS data base
4Q	Load from maximum flow (computed from concentrationand load values) and concentration reported in the MCAV field in PCS data base
4R	Load from maximum flow (computed from concentration and load values) and concentration reported in the MQMX field in PCS data base
4S	Load from maximum flow (computed from concentration and load values) and concentration reported in the MCMX field in PCS data base
4T	Load from maximum flow (computed from concentration and load values) and concentration reported in the MCMN field in PCS data base
4U	Load from average flow (computed from BOD or TSS values) and concentration reported in the MQAV field in PCS data base
4V	Load from average flow (computed from BOD or TSS values) and concentration reported in the MCAV field in PCS data base
4W	Load from average flow (computed from BOD or TSS values) and concentration reported in the MQMX field in PCS data base
4X	Load from average flow (computed from BOD or TSS values) and concentration reported in the MCMX field in PCS data base
4Y	Load from average flow (computed from BOD or TSS values) and concentration reported in the MCMN field in PCS data base

- **TPC Data**

5A	Load from average or design flow and TPC value
5B	Load from average flow (computed from concentration and load values) and TPC value
5C	Load from maximum or minimum flow and TPC value
5D	Load from maximum flow (computed from concentration and load values) and TPC value
5E	Load from average flow (computed from BOD or TSS values) and TPC value

5F	Load from typical flow and concentration reported in the MQAV field in PCS data base
5G	Load from typical flow and concentration reported in the MCAV field in PCS data base
5H	Load from typical flow and concentration reported in the MQMX field in PCS data base
5I	Load from typical flow and concentration reported in the MCMX field in PCS data base
5J	Load from typical flow and concentration reported in the MCMN field in PCS data base
5T	Load from typical flow and TPC value

- **Deleted DMR Pollutant Data**

MF	Pollutant monitoring load was deleted because of high cofficient of variation of flow data (MGD)
MM	Pollutant monitoring load was deleted because of high cofficient of variation of mass data (lbs/day)
MC	Pollutant monitoring load was deleted because of high cofficient of variation of concentration data (mg/l)
QF	Pollutant monitoring load was deleted because of questionable flow (MGD) data
QM	Pollutant monitoring load was deleted because of questionable mass (lbs/day) data
QC	Pollutant monitoring load was deleted because of questionable concentration (mg/l) data
XX	Unknown basis code (bug in computer program)

- **Flow Data**

  6A - Flow average from (50050) flow in conduit
  6B - Flow maximum from (50050) flow in conduit
  6C - Flow minimum from (50050) flow in conduit
  6D - Flow computed from concentration and load (average values)
  6E - Flow computed from concentration and load (maximum values)
  6F - Flow average from (00056) flow rate
  6G - Flow maximum from (00056) flow rate
  6H - Flow minimum from (00056) flow rate
  6I - Flow average from (00058) flow rate
  6J - Flow maximum from (00058) flow rate
  6K - Flow minimum from (00058) flow rate
  6L - Flow average from (74060) flow rate

6M - Flow maximum from (74060) flow rate
6N - Flow minimum from (74060) flow rate
6O - Flow average from (82220) flow total
6P - Flow maximum from (82220) flow total
6Q - Flow minimum from (82220) flow total
6R - Flow average from (74020) flow pump out
6S - Flow maximum from (74020) flow pump out
6T - Flow minimum from (74020) flow pump out
6U - Flow average from (50049) flow wastewater by passing TP
6V - Flow maximum from (50049) flow wastewater by passing TP
6W - Flow minimum from (50049) flow wastewater by passing TP
6X - Flow average from (78932) flow augmented water
6Y - Flow maximum from (78932) flow augmented water
6Z - Flow minimum from (78932) flow augmented water
7A - Flow average from (50047) flow max. during 24-hour period
7B - Flow maximum from (50047) flow max. during 24-hour period
7C - Flow minimum from (50047) flow max. during 24-hour period
7D - Flow average from (78720) flow recycled
7E - Flow maximum from (78720) flow recycled
7F - Flow minimum from (78720) flow recycled
7G - Flow average from (73676) flow restrictive
7H - Flow maximum from (73676) flow restrictive
7I - Flow minimum from (73676) flow restrictive
7J - Flow computed from TSS and/or BOD data
7K - Flow design from PCS
7L - Flow from permit average
7M - Flow from permit maximum
7N - Flow from permit minimum
7O - Flow from permit computed from concentration and load values (average values)
7P - Flow from permit computed from concentration and load values (maximum values)
7Q - Flow from power plants directory (average value)
7R - Actual average flow obtained from Needs Survey
7S - Present design value obtained from Needs Survey
7T - Flow from typical pollutant concentration matrix
2C-24 - Flow from permit application form (see first page of pollutant basis codes)

- **Deleted Flow Data**
  MF - DMR flow was deleted because of high cofficient of variation of flow data (MGD)
  QF - DMR flow was deleted because of questionable flow data (MGD)
  XX - Unknown (bug in computer program)

- **NOTE: A basis code can have a special character attached to it , meaning the following:**
  * - replaced DMR data because of high coefficient of variation of flow data (MGD)
  @ - replaced DMR data because of high coefficient of variation of mass data (lbs/day)
  $ - replaced DMR data because of high coefficient of variation of concentration data (mg/l)
  # - replaced DMR data because of decision rule
  { - replaced DMR data because of questionable flow data (MGD)
  / - replaced DMR data because of questionable mass data (lbs/day)

% - replaced DMR data because of questionable concentration data (mg/l)

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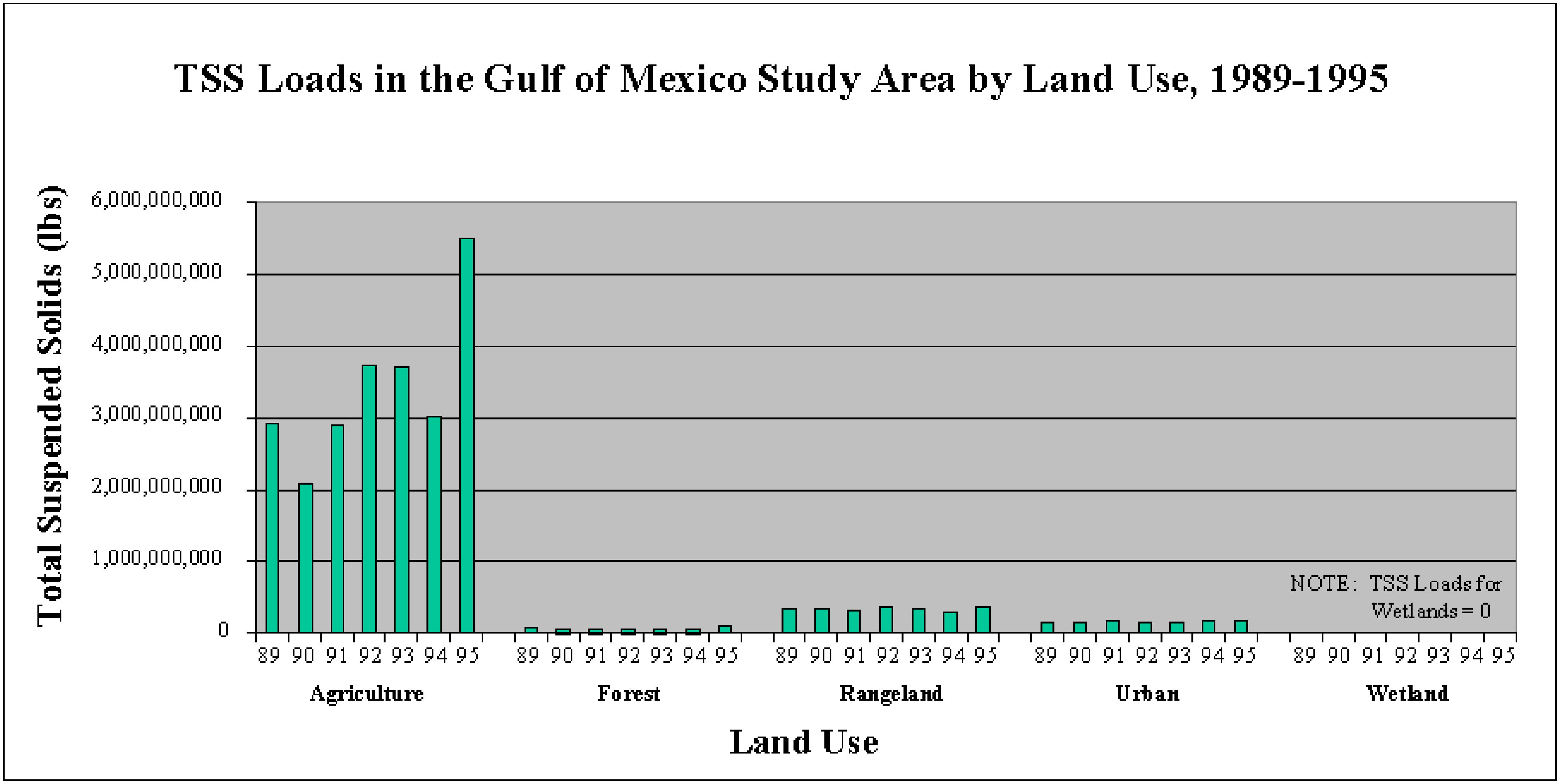

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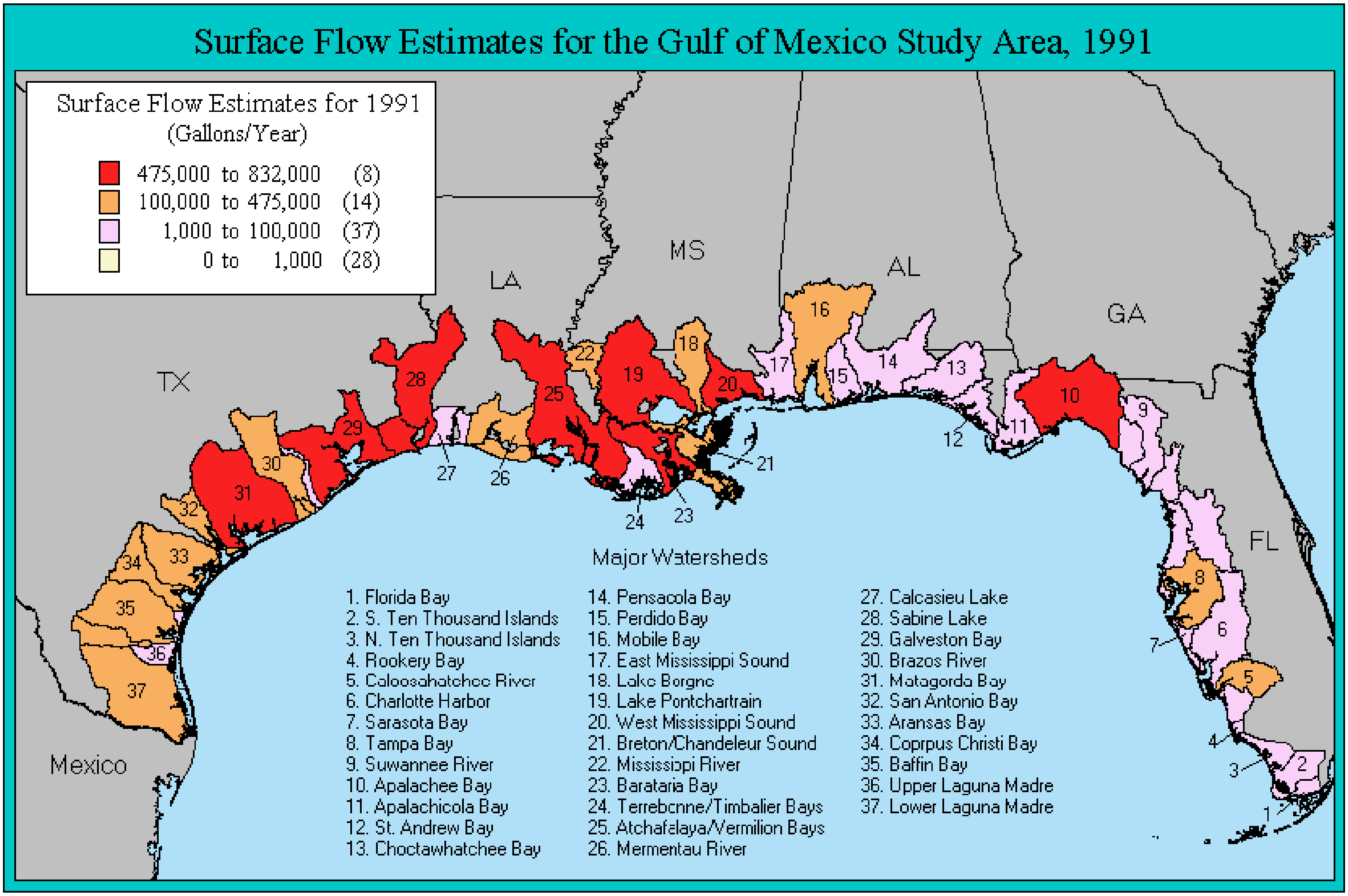

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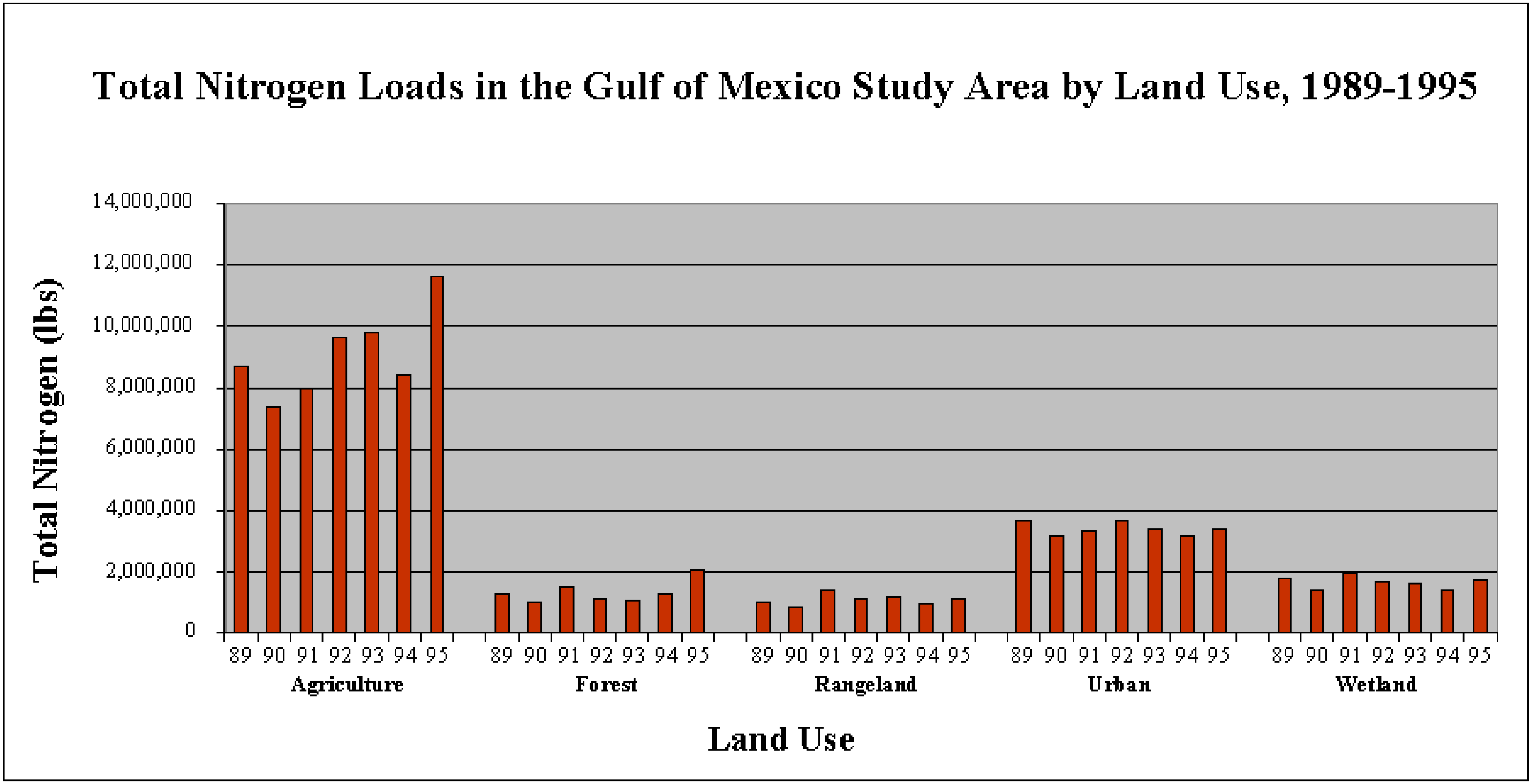

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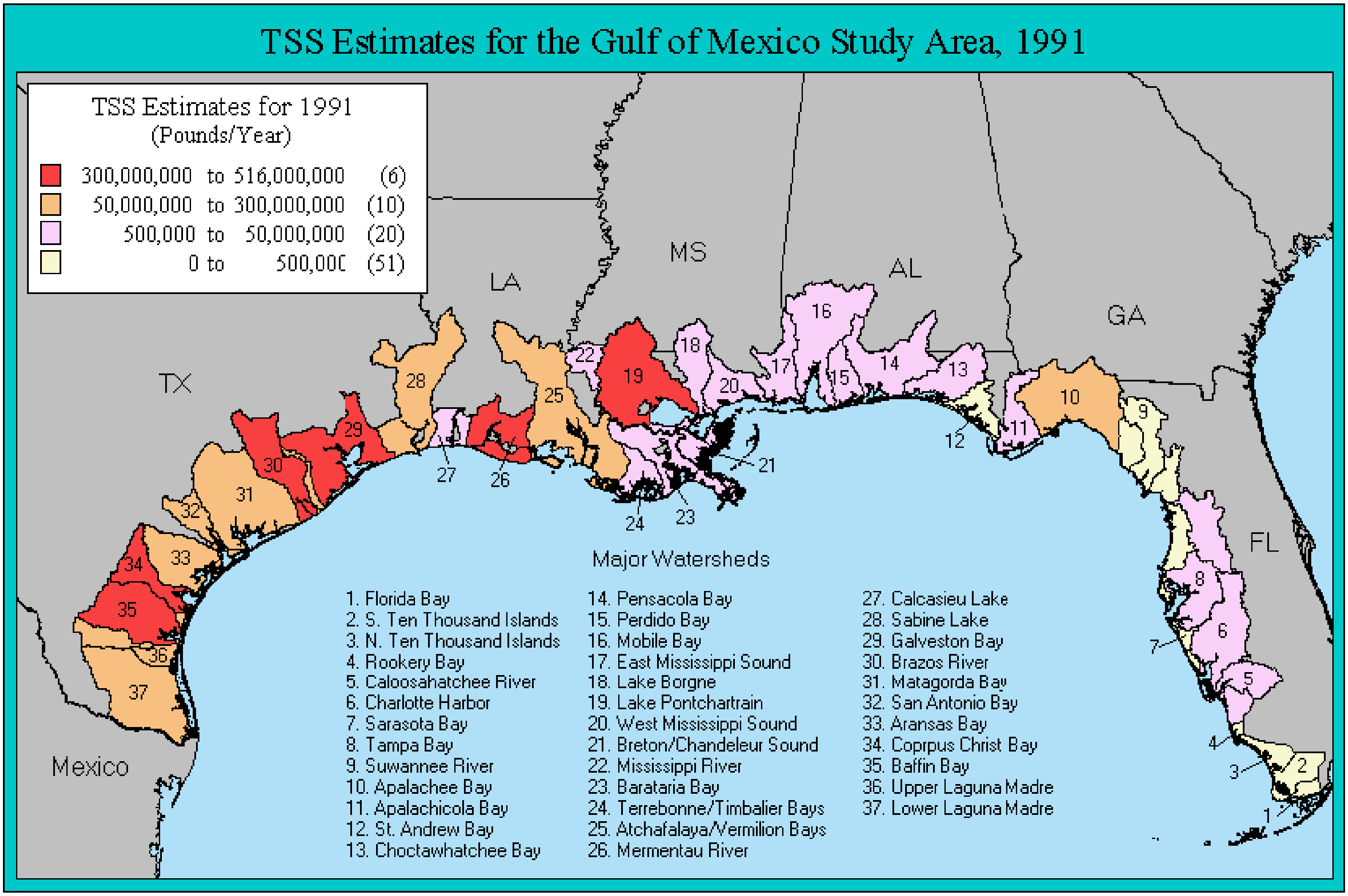

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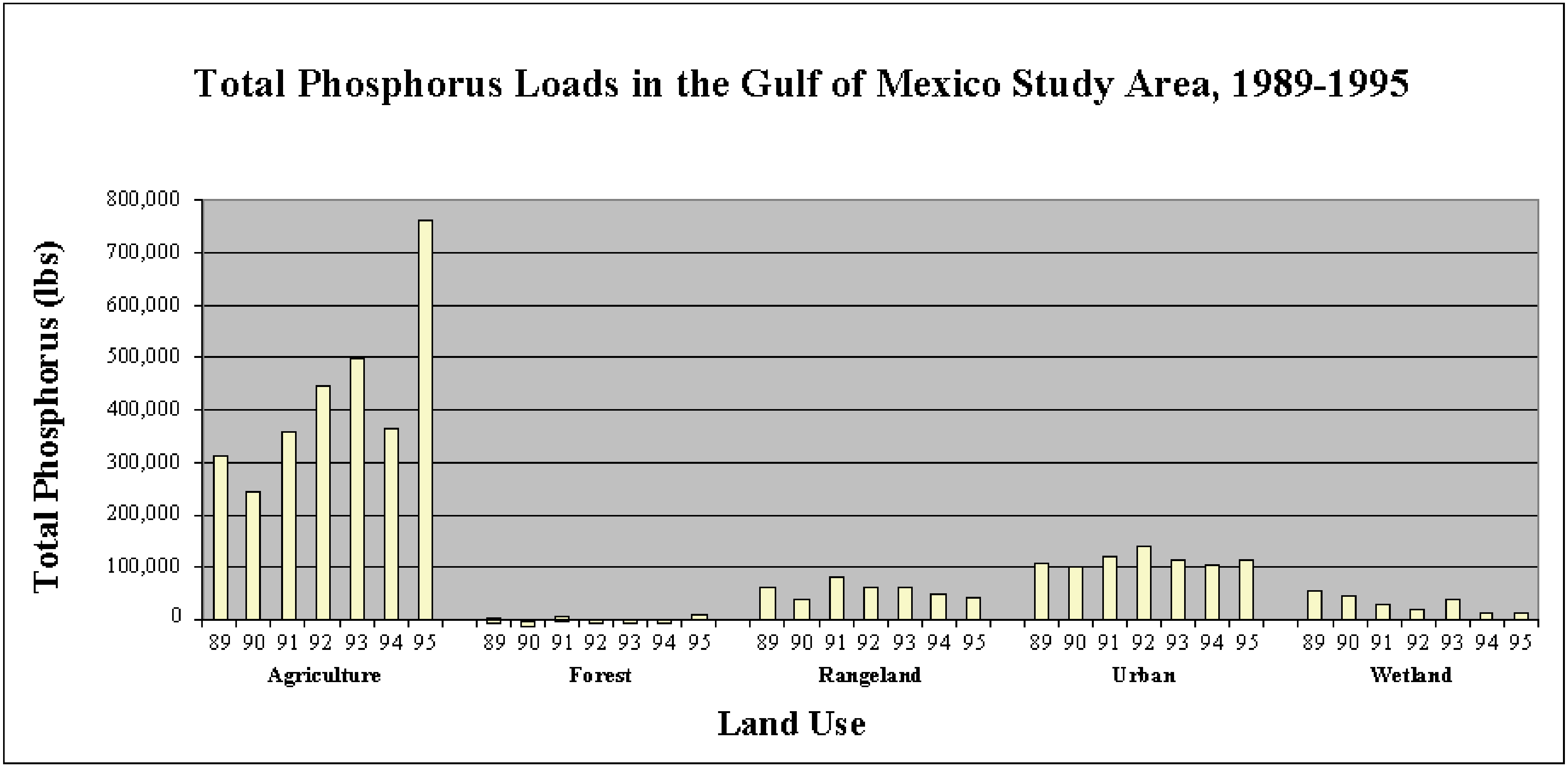

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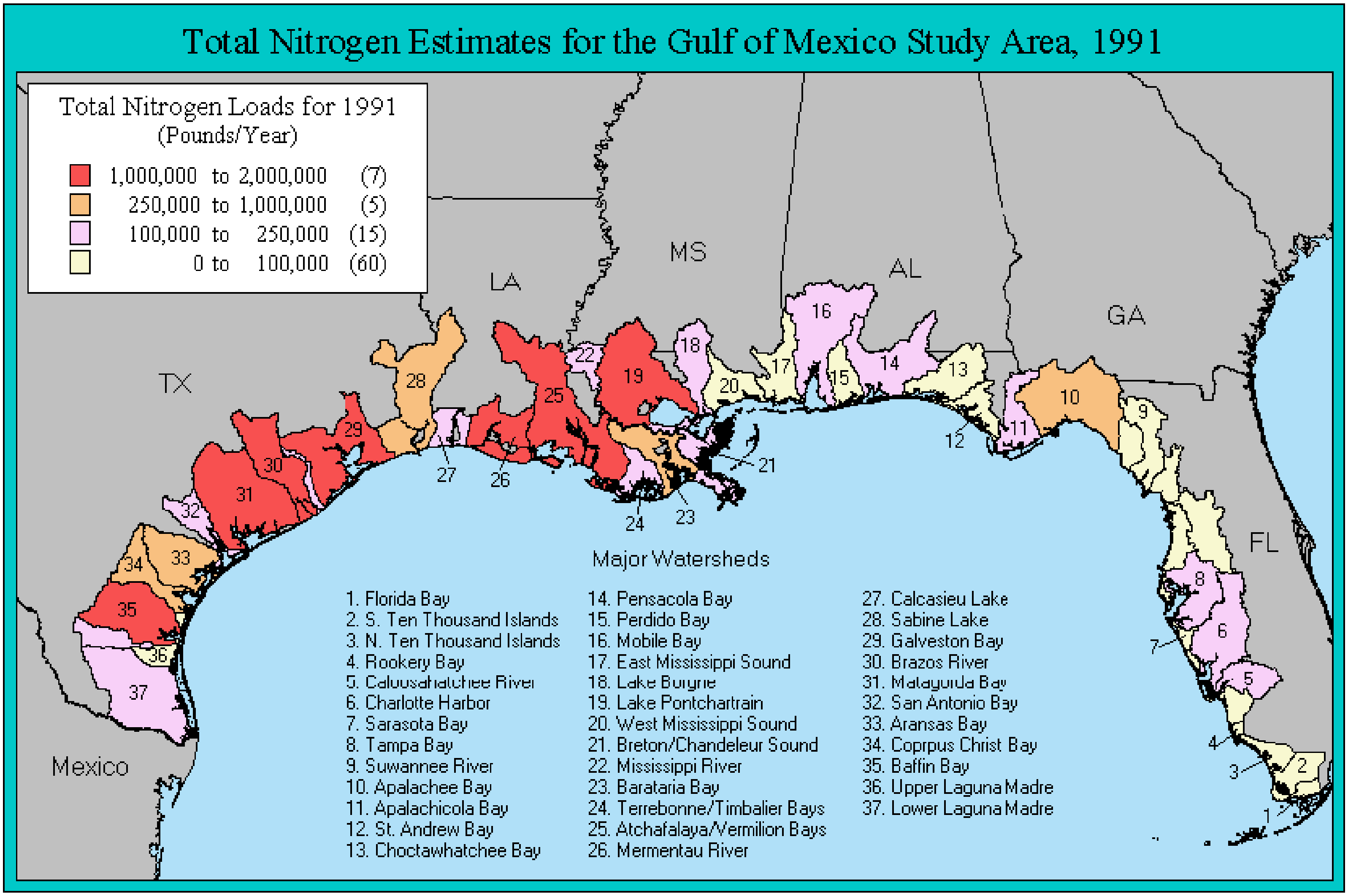

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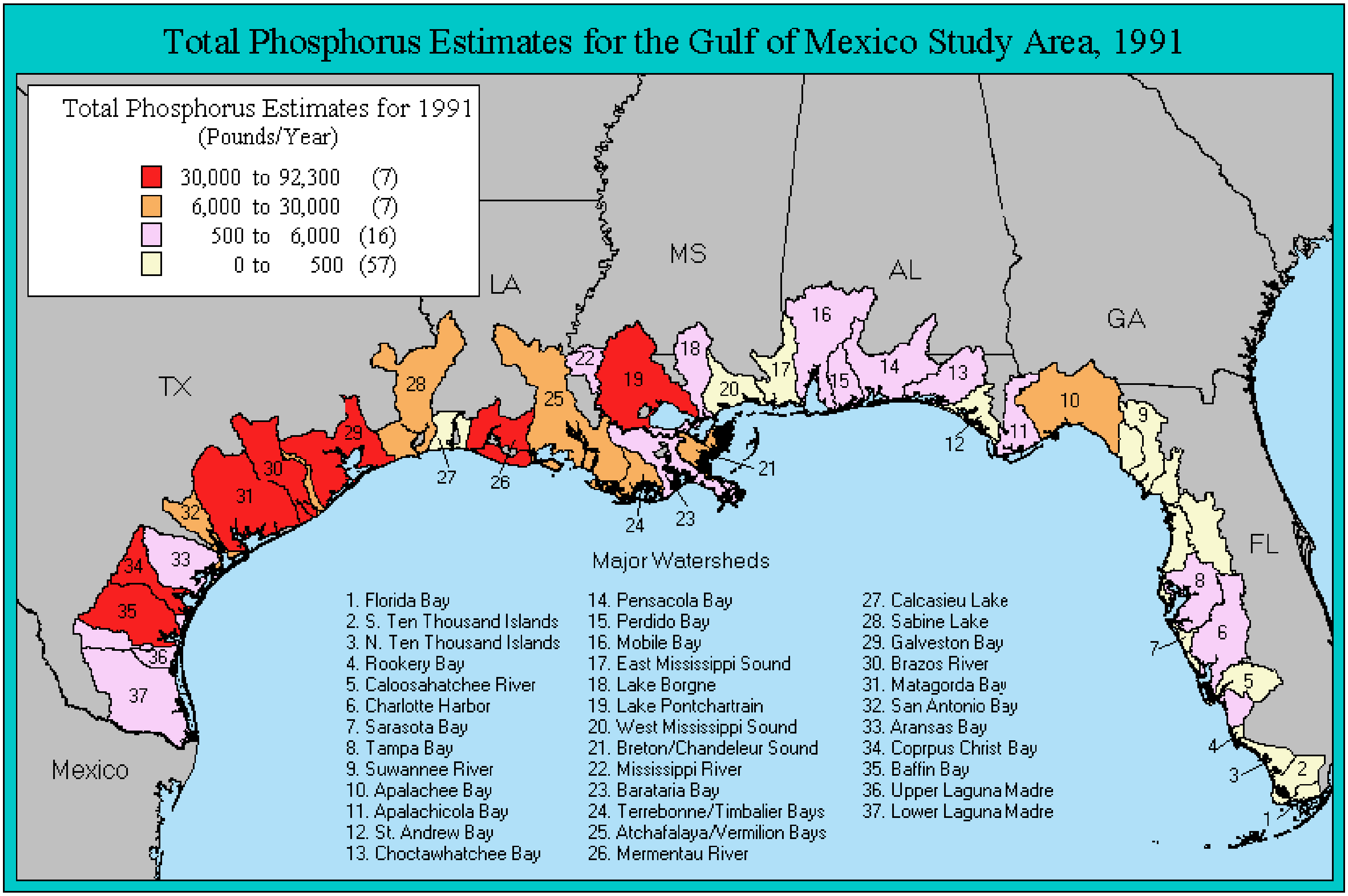

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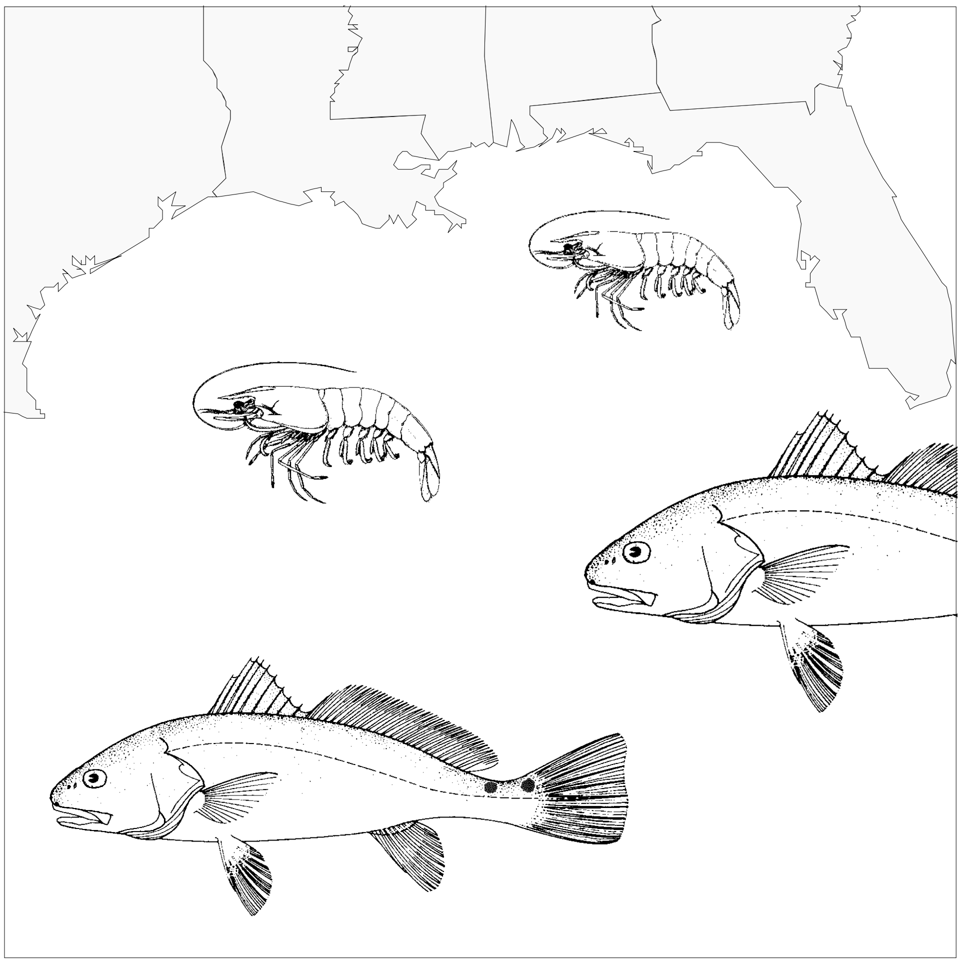
NOAA's Estuarine Living Marine Resources Program

Distribution and Abundance of Fishes and Invertebrates in Gulf of Mexico Estuaries Volume I: Data Summaries



September 1992

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service

NOAA's Estuarine Living Marine Resources Program

The Strategic Environmental Assessments (SEA) Division of NOAA's Office of Ocean Resources Conservation and Assessment (ORCA) was created in response to the need for comprehensive information on the effects of human activities on the Nation's coastal ocean. The SEA Division performs assessments of the estuarine and coastal environments and of the resources of the U.S. Exclusive Economic Zone (EEZ).

In June 1985, NOAA began a program to develop a comprehensive information base on the life history, relative abundance and distribution of fishes and invertebrates in estuaries throughout the Nation (Monaco 1986). The Estuarine Living Marine Resources (ELMR) program is conducted jointly by the SEA Division and laboratories of the National Marine Fisheries Service (NMFS). The Pt. Adams (Hammond), OR; Galveston, TX; and Beaufort, NC laboratories have compiled information for the contiguous West Coast, Gulf of Mexico, and Southeast regions. Data for the Northeast are being compiled by NOAA's SEA Division, NMFS (Annapolis, MD), the Virginia Institute of Marine Sciences, and the University of Massachusetts. To date, the program has compiled data for 115 species found in 83 estuaries. Six reports are now available free upon request (see below). This report, *Distribution and Abundance of Fishes and Invertebrates in Gulf of Mexico Estuaries, Volume I: Data Summaries*, revises and replaces earlier reports for Texas (Monaco et al. 1989), the Eastern Gulf of Mexico (Williams et al. 1990), and Central Gulf of Mexico (Czapla et al. 1991).

Three salinity zones as defined in Volume 1 of NOAA's *National Estuarine Inventory Data Atlas* (NOAA 1985) provided the spatial framework for organizing information on species distribution and abundance within each estuary. These salinity zones are tidal fresh (0.0 to 0.5 ppt), mixing (0.5 to 25 ppt), and seawater (>25 ppt). The primary data developed for each species include spatial distribution by salinity zone, temporal distribution by month, and relative abundance by life stage, e.g., adult, spawning, juvenile, larva, and egg. In addition, a detailed estuarine life history summary is written for each species.

Additional information on this or other programs of NOAA's Strategic Environmental Assessments Division is available from:

Strategic Environmental Assessments Division
Office of Ocean Resources Conservation and Assessment
National Oceanic and Atmospheric Administration
6001 Executive Blvd., Rm. 220
Rockville, Maryland 20852
FTS/Comm. (301) 443-0453/8921

Reports and reprints available from NOAA's Estuarine Living Marine Resources program include:

Monaco, M.E., et al. 1990. Distribution and abundance of fishes and invertebrates in west coast estuaries, Vol. I: data summaries. ELMR Rep. No. 4. Strategic Assessment Branch, NOS/NOAA, Rockville, MD. 240 p.

Bulger, A.J., et al. 1990. A proposed estuarine classification: analysis of species salinity ranges. ELMR Rep. No. 5. Strategic Assessment Branch, NOS/NOAA, Rockville, MD. 28 p.

Emmett, R.L., et al. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries, Vol. II: species life history summaries. ELMR Rep. No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD. 329 p.

Nelson, D.M., et al. 1991. Distribution and abundance of fishes and invertebrates in southeast estuaries. ELMR Rep. No. 9. NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD. 177 p.

Monaco, M.E., et al. 1992. Assemblages of U.S. west coast estuaries based on the distribution of fishes. Journal of Biogeography 19: 251-267.

Nelson, D.M. (editor). 1992. Distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries, Vol. I: data summaries. ELMR Rep. No. 10. NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD. 273 p.

Pattillo, M.E., et al. In prep. Distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries, Vol. II: species life history summaries. ELMR Rep. No. 11. NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD.

Distribution and Abundance of Fishes and Invertebrates in Gulf of Mexico Estuaries Volume I: Data Summaries

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September 1992

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Introduction

This report presents information on the spatial and temporal distribution, and relative abundance of 44 fish and invertebrate species in 31 estuaries along the Gulf of Mexico coast of Florida, Alabama, Mississippi, Louisiana, and Texas. Its purpose is to disseminate data developed in the National Oceanic and Atmospheric Administration's (NOAA) Estuarine Living Marine Resources (ELMR) program (see inside front cover). The ELMR program is conducted through a series of joint regional studies by the National Ocean Service (NOS) and National Marine Fisheries Service (NMFS). The presence, distribution, and relative abundance of each species and the time period it utilizes each estuary are the primary data compiled. The data and framework presented are illustrative of the nationwide ELMR program.

This report, *Volume I*, combines information presented in earlier reports for nine estuaries in Texas (Monaco et al. 1989), 13 estuaries in Florida and Alabama (Williams et al. 1990), and nine estuaries in Louisiana and Mississippi (Czapla et al. 1991). However, several species have been added, and the graphic depiction of relative abundance has been improved. *Volume II* (Pattillo et al., in prep.), to be published in 1993, will present life history summaries for 44 fish and invertebrate species, and focus on how these individual species utilize Gulf of Mexico estuaries.

The objective of the ELMR program is to develop a consistent data base on the distribution, abundance, and life history characteristics of important fishes and invertebrates in the Nation's estuaries. The Nationwide data base is divided into four study regions (Figure 1). The data base contains the relative abundance and monthly occurrence of each species' life stage by estuary for three salinity zones (seawater, mixing, and tidal fresh) identified in NOAA's National Estuarine Inventory (NEI) Data Atlas-Volume I (NOAA 1985). When completed, the entire data base will contain information for 135 fish and invertebrate species found in 118 U.S. estuaries.

Rationale

Estuaries are among the most productive natural systems and are important nursery areas that provide food, refuge from predation, and valuable habitat for many species (Gunter 1967, Joseph 1973, Weinstein 1979, Mann 1982). Estuarine organisms that support important commercial and recreational fisheries include shrimp, crabs, and sciaenids. In spite of the well-documented importance of estuaries to fishes and invertebrates, few consistent and comprehensive data bases exist which allow examinations of the relationships between estuarine species found in or among groups of estuaries. Furthermore, much of the distribution and abundance information for estuarine-dependent species (i.e., species that require estuaries during

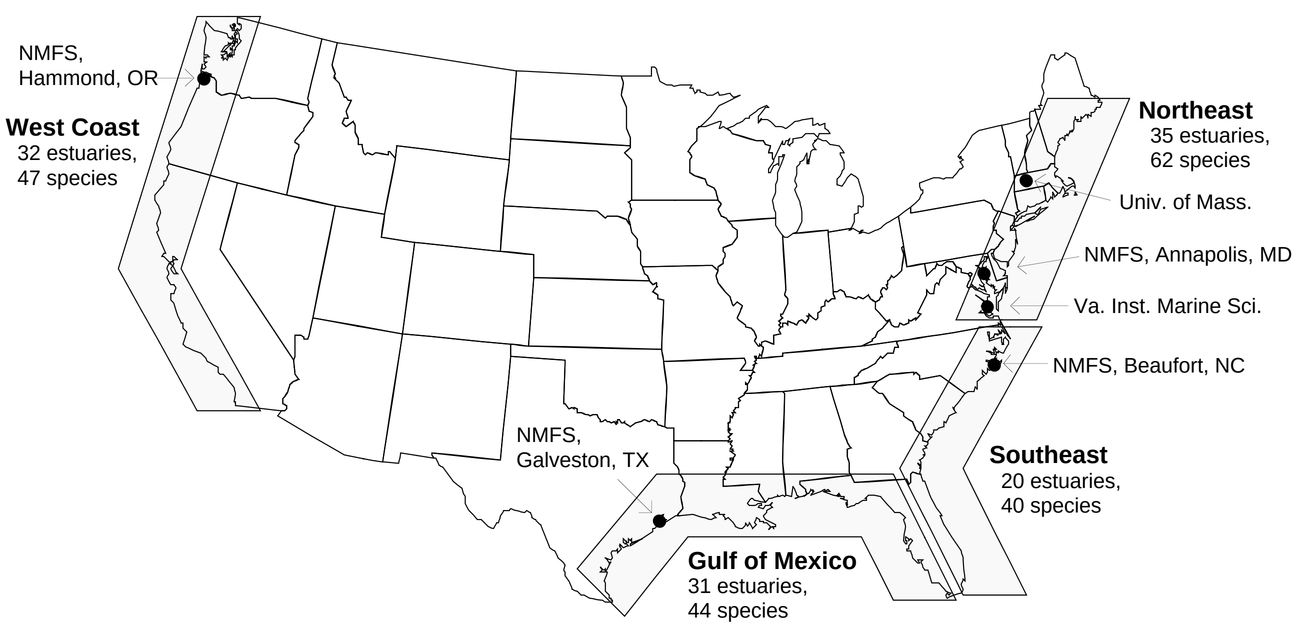

Figure 1. ELMR study regions and regional research laboratories.

their life cycle) is for offshore life stages and does not adequately describe estuarine distributions (Darnell et al. 1983, NOAA 1988).

Only a few comprehensive sampling programs (e.g., states of Louisiana and Texas) collect fishes and invertebrates with identical methods across groups of estuaries within a region (Barrett et al. 1978, Hammerschmidt and McEachron 1986). Therefore, most existing estuarine fisheries data cannot be compared among estuaries because of the variable sampling strategies. In addition, existing research programs do not focus on how groups of estuaries may be important for regional fishery management, and few compile information for species having little or no economic value.

Because life stages of many species use both estuarine and marine habitats, information on distribution, abundance, temporal utilization, and life history characteristics are needed to understand the coupling of estuarine, nearshore, and offshore habitats. To date, a national, comprehensive, and consistent data base of this type does not exist. Consequently, there is a need to develop a program that integrates fragments of information on marine and estuarine species and their associated habitats into a useful, comprehensive, and consistent format. The ELMR program was designed to help fulfill this need by developing a uniform nationwide data base on selected estuarine species. Results will complement NOAA efforts to develop a national estuarine assessment capability (NOAA 1985), identify information gaps, and assess the content and quality of existing estuarine fisheries data. In addition, the ELMR program provides the estuarine distribution data for NOAA's recently initiated East Coast of North America Strategic Assessment project (NOAA 1991). An objective of this project is to map species distributions from the head-of-tide in estuaries to the far reaches of the continental shelf.

Data Collection and Organization

Figure 2 summarizes the major steps taken to collect and organize information on the distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries. The initial steps were selecting the estuaries and the species to be studied.

Selection of estuaries. Gulf of Mexico estuaries were selected from the National Estuarine Inventory (NEI) Data Atlas-Volume I (NOAA 1985) and NEI Supplement 3 (Shirzad et al. 1989). The 31 estuaries selected are listed in Table 1, and their locations shown in Figure 3.

Data on spatial and temporal distributions of species were developed and organized by the tidal fresh (0.0 to 0.5 parts per thousand (ppt)), mixing (0.5 to 25.0 ppt), and seawater (>25.0 ppt) zones delineated for each estuary in the NEI. Each salinity zone is represented in 17 of the Gulf of Mexico estuaries, but 14 estuaries are missing at least one zone (Table 1). A representative map and data table for Mobile Bay from the NEI Data Atlas is shown in Appendix 1.

Compiling consistent data nationwide limits the amount of information that may be compiled for each species and estuary. Also, it would be time- and cost-prohibitive to map each species by life stage for each estuary (Monaco 1986). The NOAA framework allows for a consistent compilation and organization of available information on the distribution of fishes and invertebrates in estuaries.

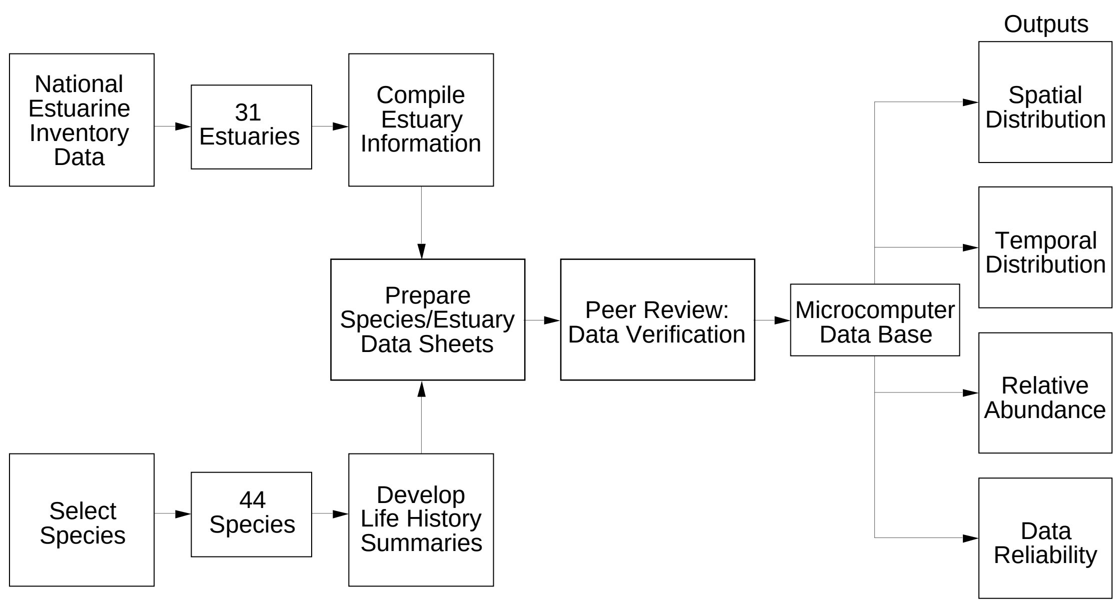

Figure 2. Major steps to complete the Gulf of Mexico ELMR study.

Table 1. ELMR Gulf of Mexico estuaries (n=31) and associated salinity zones.

Estuary, State	Zones present
Florida Bay, FL	T M S
Ten Thousand Islands, FL	T M S
Caloosahatchee River, FL	T M *
Charlotte Harbor, FL	T M S
Tampa Bay, FL	T M S
Suwannee River, FL	T M S
Apalachee Bay, FL	T M S
Apalachicola Bay, FL	T M S
St. Andrew Bay, FL	T M S
Choctawhatchee Bay, FL	T M S
Pensacola Bay, FL	T M S
Perdido Bay, FL/AL	T M S
Mobile Bay, AL	T M S
Mississippi Sound, MS/AL/LA	T M S
Lake Borgne, LA	T M *
Lake Pontchartrain, LA	* M *
Breton/Chandeleur Sounds, LA	* M S
Mississippi River, LA	T M *
Barataria Bay, LA	T M S
Terrebonne/Timbalier Bays, LA	T M S
Atchafalaya/Vermilion Bays, LA	T M *
Calcasieu Lake, LA	T M *
Sabine Lake, LA/TX	T M *
Galveston Bay, TX	T M S
Brazos River, TX	T M *
Matagorda Bay, TX	T M S
San Antonio Bay, TX	* M S
Aransas Bay, TX	* M S
Corpus Christi Bay, TX	T M S
Laguna Madre, TX	* * S
Baffin Bay, TX	* * S

T - Tidal fresh zone
M - Mixing zone
S - Seawater zone
* - salinity zone not present

Table 2. ELMR Gulf of Mexico species (n=44).

Common Name	Scientific Name
Bay scallop	*Argopecten irradians*
American oyster	*Crassostrea virginica**
Common rangia	*Rangia cuneata**
Hard clam	*Mercenaria* species*
Bay squid	*Lolliguncula brevis**
Brown shrimp	*Penaeus aztecus*
Pink shrimp	*Penaeus duorarum*
White shrimp	*Penaeus setiferus*
Grass shrimp	*Palaemonetes pugio**
Spiny lobster	*Panulirus argus**
Blue crab	*Callinectes sapidus*
Gulf stone crab	*Menippe adina*
Stone crab	*Menippe mercenaria**
Bull shark	*Carcharhinus leucas*
Tarpon	*Megalops atlanticus*
Alabama shad	*Alosa alabamae*
Gulf menhaden	*Brevoortia patronus*
Yellowfin menhaden	*Brevoortia smithi*
Gizzard shad	*Dorosoma cepedianum*
Bay anchovy	*Anchoa mitchilli*
Hardhead catfish	*Arius felis*
Sheepshead minnow	*Cyprinodon variegatus*
Gulf killifish	*Fundulus grandis*
Silversides	*Menidia* species*
Snook	*Centropomus undecimalis**
Bluefish	*Pomatomus saltatrix*
Blue runner	*Caranx crysos*
Crevalle jack	*Caranx hippos*
Florida pompano	*Trachinotus carolinus*
Gray snapper	*Lutjanus griseus*
Sheepshead	*Archosargus probatocephalus*
Pinfish	*Lagodon rhomboides*
Silver perch	*Bairdiella chrysoura*
Sand seatrout	*Cynoscion arenarius*
Spotted seatrout	*Cynoscion nebulosus*
Spot	*Leiostomus xanthurus*
Atlantic croaker	*Micropogonias undulatus*
Black drum	*Pogonias cromis*
Red drum	*Sciaenops ocellatus*
Striped mullet	*Mugil cephalus*
Code goby	*Gobiosoma robustum*
Spanish mackerel	*Scomberomorus maculatus*
Gulf flounder	*Paralichthys albigutta*
Southern flounder	*Paralichthys lethostigma*

*See Life History Notes, pp. 8-10.

Selection of species. Four criteria were used to identify 44 species that had sufficient available information for inclusion in the ELMR data base (Table 2). The four criteria were:

1) Commercial value - determined by review of catch data and value statistics from NMFS and state agencies, e.g., Gulf menhaden (*Brevoortia patronus*) and penaeid shrimp (*Penaeus* sp.).

2) Recreational value - defined as a species that recreational fishermen specifically try to catch, that may or may not be of commercial importance. Recreational species were determined by consulting regional experts and NMFS reports, e.g., spotted seatrout (*Cynoscion nebulosus*) and red drum (*Sciaenops ocellatus*).

3) Indicator species of environmental stress - identified from the literature, discussions with fisheries experts, and from monitoring programs such as NOAA's National Status and Trends Program (O'Connor 1990). These species (e.g., American oyster, *Crassostrea virginica*, and Atlantic croaker, *Micropogonias undulatus*) are molluscs or demersal fishes that consume benthic invertebrates or have a strong association with bottom sediments. Their physiological disorders, morphological abnormalities, and bioaccumulation of contaminants, such as heavy metals, indicate episodes of environmental pollution and/or stress.

4) Ecological value - based on several attributes, including trophic level, relative abundance and importance as a key predator or prey species, e.g., bay anchovy, *Anchoa mitchilli*.

Figure 3. ELMR Gulf of Mexico estuaries.

Data sheets. A data sheet was developed for each species in each estuary to enable quick data compilation and presentation. Figure 4 depicts the data sheet for spotted seatrout (*Cynoscion nebulosus*) in Mobile Bay. Data sheets were developed by project staff and reviewed by local experts. Data compiled for each species/life stage included: 1) the salinity zone it occupies (seawater, mixing, tidal fresh), 2) its monthly distribution in those zones, and 3) its relative abundance in the zones. The ELMR data sheets were entered into a microcomputer data base management system.

The relative abundance of a species was classified using the following categories:

• Not present: species or life history stage not found, questionable data as to identification of species, and/or recent loss of habitat or environmental degradation suggests absence.

• No information available: no existing data available, and after expert review it was determined that not even an educated guess would be appropriate.

• Rare: species is definitely present but not frequently encountered.

• Common: species is frequently encountered but not in large numbers; does not imply a uniform distribution over a specific salinity zone.

• Abundant: species is often encountered in substantial numbers relative to other species.

• Highly abundant: species is numerically dominant relative to other species.

Adults were defined as reproductively mature individuals, juveniles as immature but otherwise similar to adults, and spawning adults as those releasing eggs and sperm. There were a few exceptions to these defined life stages, such as mating in crabs.

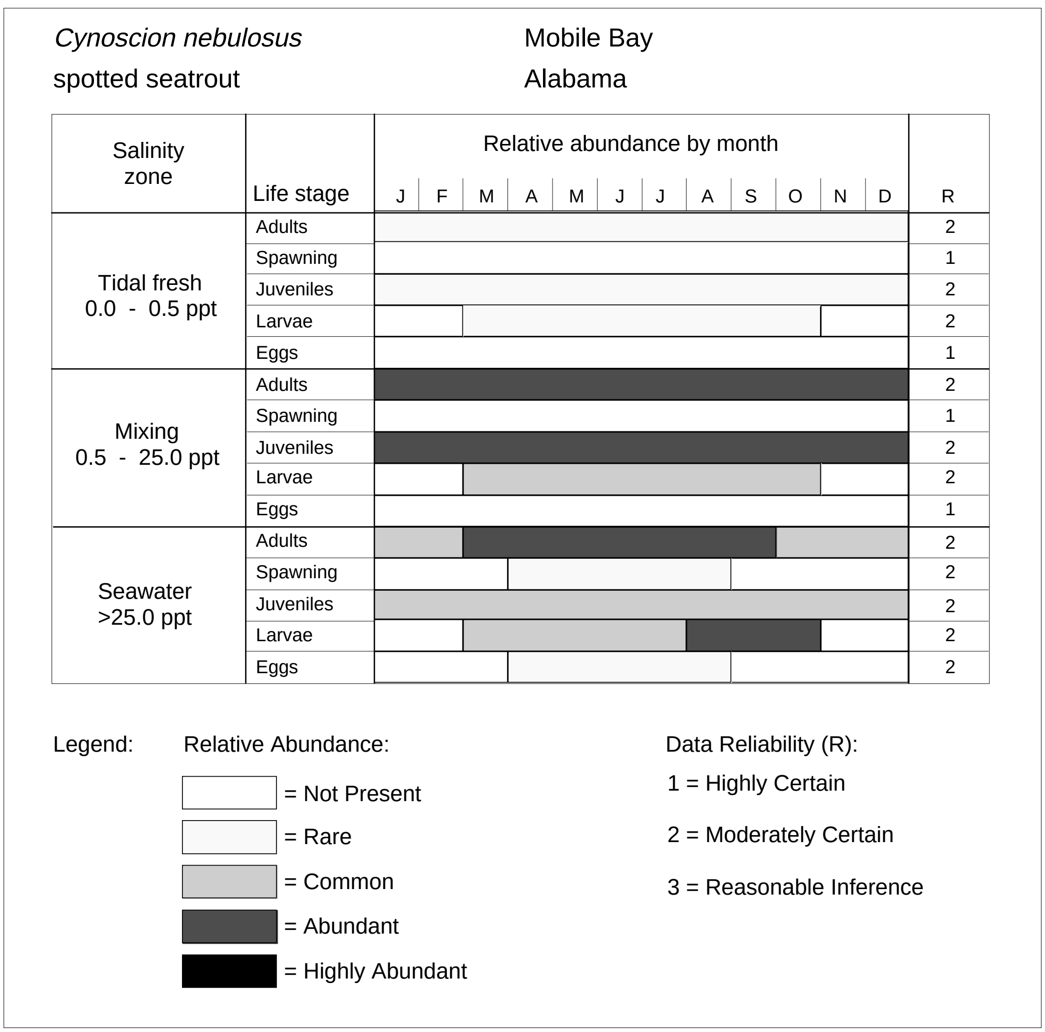

Figure 4. Example of a species/estuary data sheet: spotted seatrout in Mobile Bay.

For well-studied species such as penaeid shrimp, quantitative data were used to estimate abundance levels. For many species, however, reliable quantitative data were limited. Therefore, regional and local experts were consulted to estimate relative abundances based on the above criteria. Several reference or "guide" species with abundance levels corresponding to the above criteria were identified for each estuary. These guide species typified fishes and invertebrates belonging to a particular life mode (e.g., pelagic, demersal) or occupying similar habitats. Once guide species were selected, other species were then placed into the appropriate abundance categories relative to them. These data represent relative abundance levels within a specific estuary only; relative abundance levels across Gulf of Mexico estuaries could not be determined.

The final level of abundance assigned to a species was determined by asking regional and local biologists for expert opinions based on their knowledge of individual species within an estuary. This effort complemented quantitative studies, the ELMR relative abundance categories, and greatly increased reliability of abundance information. The quality of relative abundance information varied between estuaries as well as species. As a result, temporal resolution was greater in well-studied estuaries. Nevertheless, the relative abundance data shown in the data summaries are the best that could be synthesized from agency reports, academic studies, and expert reviews.

Data verification. Approximately two years were required to develop the 1,364 data sheets (Figure 4) and consult with regional and local experts for the 31 estuaries studied. Nearly all of the data sheets were carefully reviewed during consultations or by mail. These consultations complemented the literature and published data sets compiled by NOAA. Ninety-four scientists and managers at 44 institutions were consulted. Local experts were especially helpful in providing estuary/species-specific information. They also provided additional references and contacts, and identified additional species to be included in the ELMR data base. The names and affiliations of these experts are listed in Appendix 3.

Results

Presence/absence. Table 3 (pp. 16-17) was developed to readily convey the occurrence of each of the 44 ELMR species in each of the 31 Gulf of Mexico estuaries. The highest level of abundance during the year for the adult or juvenile life stages is depicted. The spawning, egg, and larval categories are not considered. This table suggests the zoogeographic distribution of species between Gulf of Mexico estuaries.

Data summary tables. The information compiled for each species and estuary (1,364 data sheets) was organized in three data summaries (pp. 19-191). Tables 4 and 5 provide graphic presentations of the spatial and temporal distribution and relative abundance by life stage for each species and estuary. The information shown represents the usual spatial and temporal distribution of a species in a particular estuary. Table 6 ranks the relative reliability of the information presented for each species and estuary.

Spatial distribution and relative abundance. Table 4 (pp. 19-59) summarizes the distribution and relative abundance for each species by life stage, in each estuary by salinity zone. The highest level of abundance during the year in each estuary is depicted.

Temporal distribution. Table 5 (pp. 61-149) summarizes the temporal distribution of each species by month and life stage for each estuary. This table combines data over the three salinity zones, showing the highest level of abundance for a particular life stage by month.

Data Content and Quality

An important aspect of the ELMR program, especially since it is based primarily on published and unpublished literature and consultations, is to determine the quality of available data. For many species, gear selectivity, difficulty in identifying larvae, and difficulty in sampling various habitats has limited the amount of reliable information. Therefore, a deliberate effort was made to assess the overall reliability of the data base so that it could be used appropriately.

Estimates of the reliability of the distribution and abundance information organized by species, life stage, and estuary are presented in Table 6 (pp. 151-190) of the *Data Summary Tables* section. Data reliability was classified using the following categories:

• Highly certain: Considerable sampling data available. Distribution, behavior, and preferred habitats well documented within an estuary.

• Moderately certain: Some sampling data available for an estuary. Distribution, preferred habitat, and behavior well documented in similar estuaries.

• Reasonable inference: Little or no sampling data available. Information on distributions, ecology, and preferred habitats documented in similar estuaries.

The quality and quantity of available data vary by species, life stage, and estuary. For example, a large amount of information is available on the blue crab because it is highly valued both commercially and recreationally. The least amount of information available and poorest quality of data occur for the spawning, egg, and larval life stages. Except for a few species (e.g., blue crab), very little data has been generated on specific habitat preferences and *in situ* environmental ranges. This is particularly true for the smaller forage and/or non-commercial fishes and invertebrates. Gear selectivity, inability to correctly identify larval stages, and difficulty of sampling various habitats limits the development and reliability of this information. In addition, life history data are lacking on some of the commercially important sciaenid and pelagic species.

Data reliability was also based on experimental design and whether the studies were relatively recent. In the case of limited studies, information was occasionally inferred. An opportunity exists to refine the data presented based on additional reviews.

Given that the amount and quality of available information vary by species, by life stage, between estuaries, and even within an estuary, considerable scientific judgment is required to derive or infer spatial and temporal distributions from existing data and available literature. Unfortunately, even the most informed judgment is far from perfect due to the complexity of estuarine systems. Consequently, information on the level of certainty associated with each data element must be presented when synthesizing multiple data sets (Table 6). Appendices 2, 3, and 4 provide a complete summary of the personal communications and primary references used so that readers can track and obtain additional information efficiently.

Analysis of data content and quality. To assess the overall certainty of the ELMR Gulf of Mexico data, mean data reliability was calculated by estuary, salinity zone, species, and life stage. In this analysis, "highly certain" = 3, "moderately certain" = 2, and "reasonable inference" = 1. Mean data reliability was calculated using values for only those species and life stages known to occur within an estuary, i.e., those with a relative abundance of at least "rare" during some part of the year. This was because species and life stages known to be absent were typically scored as highly certain.

This analysis identified estuaries, species, and life stages that have the most reliable information, and those with the least. This information suggests species, life stages, and estuaries that could be the focus of research efforts. Future research should include a comprehensive and consistent sampling program to quantify species distributions and abundances within and across estuaries. In addition, life history requirements need to be determined, especially for those species that may not have economic value, but are ecologically important.

Mean data reliability of fish and invertebrate data ranged from a high of 2.08 for Florida Bay to a low of 1.00 for Brazos River, with an overall average of 1.86 (Figure 5). In general, the reliability scores reflect the amount of fisheries research that has been conducted within an estuary. Reliability scores were especially high for Florida Bay, Tampa Bay, Barataria Bay, and Galveston Bay, all of which are fairly large coastal embayments. They were especially low for the Suwannee and Brazos Rivers, both of which are fairly small tidal rivers.

When averaged across estuaries and analyzed by salinity zone, data reliability scores were lower in the tidal fresh zone than in the mixing and seawater zones (Figure 6). This may occur because the selected species are primarily estuarine, not freshwater, and may also be indicative of fewer studies of tidal fresh waters.

When averaged across estuaries and analyzed by species, mean data reliability scores ranged from a high of 2.49 for brown shrimp to a low of 1.46 for gulf stone crab (Figure 7). Of the invertebrate species, reliability scores were highest for penaeid shrimp and blue crab. They were fairly low for gulf stone crab, spiny lobster, bay squid, and hard clam. Of the fish species, reliability scores were fairly high for gulf and yellowfin menhaden, bay anchovy, pinfish, spotted seatrout, and Atlantic croaker. They were fairly low for bull shark, sheepshead minnow, silversides, and code goby. In general, the reliability scores reflect the amount of fisheries research directed towards different species. Reliabilities were especially high for species with high commercial value (e.g., penaeid shrimp, menhaden), recreational value (e.g., spotted seatrout), or ecological value (e.g., bay anchovy). Reliabilities tended to be lower for species with low commercial and recreational value (e.g., bay squid, silversides, sheepshead minnow, code goby), even though these species are ecologically important and fairly abundant. Low data reliability scores for gulf stone crab may also be because of its relatively recent recognition as a separate species (Williams and Felder 1986).

When analyzed by life stage, data for juvenile and adult life stages were most reliable, while data for spawning, larvae, and eggs were less certain (Figure 8). This reflects the number of research studies that have focused on adult and juvenile life stages. Species-specific studies of spawning, eggs, and larvae have not been conducted in most estuaries. Thus, some of the information for these life stages was inferred from life history studies and data from similar estuaries.

Variability in space and time. Species data were organized according to the salinity zone boundaries developed for each estuary in the NEI data atlas-Volume 1 (NOAA 1985). However, division of an estuary on the basis of salinity is highly variable due to the many interacting factors that affect salinity, such as variations in freshwater inflow, wind, and tides. To compile information on species distribution according to these zones, it is assumed that if a particular salinity zone expands or contracts, the distribution of a mobile species in that zone will correspond to the shift. For example, if increased freshwater inflow shifts the tidal fresh zone further down the estuary, the distribution of a species confined to that zone increases to include the new area. If a species exhibits a wide range of salinity tolerance, a shift may or may not occur. The placement of species in a salinity zone was ultimately determined by where they have been observed or captured.

Species temporal distributions are often dependent on annual climatic conditions and water currents. Monthly distributional patterns were derived based on the consistent presence of a life stage within a particular month. If a species is only present in an estuary in unusual years (e.g., drought), this was not portrayed as part of that species' spatial or temporal distribution. However, if a species usually occurs, even during a restricted time period, it was considered present for the specific month(s). Greater temporal resolution, such as on a biweekly rather than on a monthly basis, was not possible.

Life history notes. Because of the complex life histories of some species, the following comments are provided below to clarify and supplement information presented in the data summary tables.

Invertebrates. Sessile invertebrates, such as clams and oysters, usually have a patchy rather than a uniform distribution. Therefore, the ELMR framework may overestimate the areal distribution of these organisms, but identify the salinity zones of colonization. Specific areas may contain acceptable salinity regimes, but suitable bottom habitat for colonization may not exist. Specific habitat requirements and life history characteristics of a number of invertebrate species are provided below:

• Bay scallop: Usually associated with seagrass beds and salinities greater than 25 ppt.

• American oyster: Also known as eastern oyster (Turgeon et al. 1988). Prefers hard substrate in intertidal and subtidal estuarine waters.

• Common rangia: Also known as Atlantic rangia (Turgeon et al. 1988). All life stages occur in salinities below 25 ppt. Not common in the south Florida and south Texas estuaries, which have relatively high salinities.

• Hard clam: Also known as quahog (Turgeon et al. 1988). Most life stages occur in salinities above 20 ppt. Two species occur in the Gulf of Mexico, and hybridization may occur. The northern quahog (*Mercenaria mercenaria*) is generally found in intertidal and subtidal waters to 15 m, and the southern quahog (*Mercenaria campechiensis*) in deeper, more saline waters. The two species are considered together in this report because most fisheries data do not distinguish between them.

• Bay squid: Also known as Atlantic brief squid (Turgeon et al. 1988). The lower lethal salinity limit is approximately 17 ppt, and bay squid actively avoid salinities that are lower than this. Therefore, the distribution of juveniles and adults will only be from the lower mixing zone to the seawater zone, and out to the nearshore waters of the Gulf of Mexico.

• Penaeid shrimp: Postlarvae and juveniles are the main life stages utilizing the estuaries. Adults generally move to nearshore spawning grounds, where spawning, egg development, and most of the larval development occur. Brown and white shrimp are generally more abundant in the central and western Gulf of Mexico, whereas pink shrimp are generally more abundant in the eastern Gulf of Mexico.

• Grass shrimp: Also known as daggerblade grass shrimp (Williams et al. 1989). Most abundant in vegetated or oyster reef habitat. Fertilized eggs are held on the female's pleopods until hatching. In higher salinities, *Palaemonetes pugio* is often replaced by brackish grass shrimp (*P. intermedius*) and/or marsh grass shrimp (*P. vulgaris*).

• Spiny lobster: Also known as Caribbean spiny lobster (Williams et al. 1989). Found in the Gulf of Mexico estuaries of southern Florida and southern Texas. Juveniles do not mature into adults until 6-8 years of age. Life stages considered in this report are adults, mating (instead of spawning), juveniles, larvae, and eggs.

• Blue crab: Mating usually takes place in the low salinities of the tidal fresh to the upper region of the mixing zone. After mating, females move to the seawater zone, while males often remain in the upper reaches of the estuary. Females brood the eggs (sponge females), and larvae are released in higher salinities. Development through the late zoeal stages occurs offshore. Megalopae are transported back into the estuary and disperse throughout the salinity zones. As

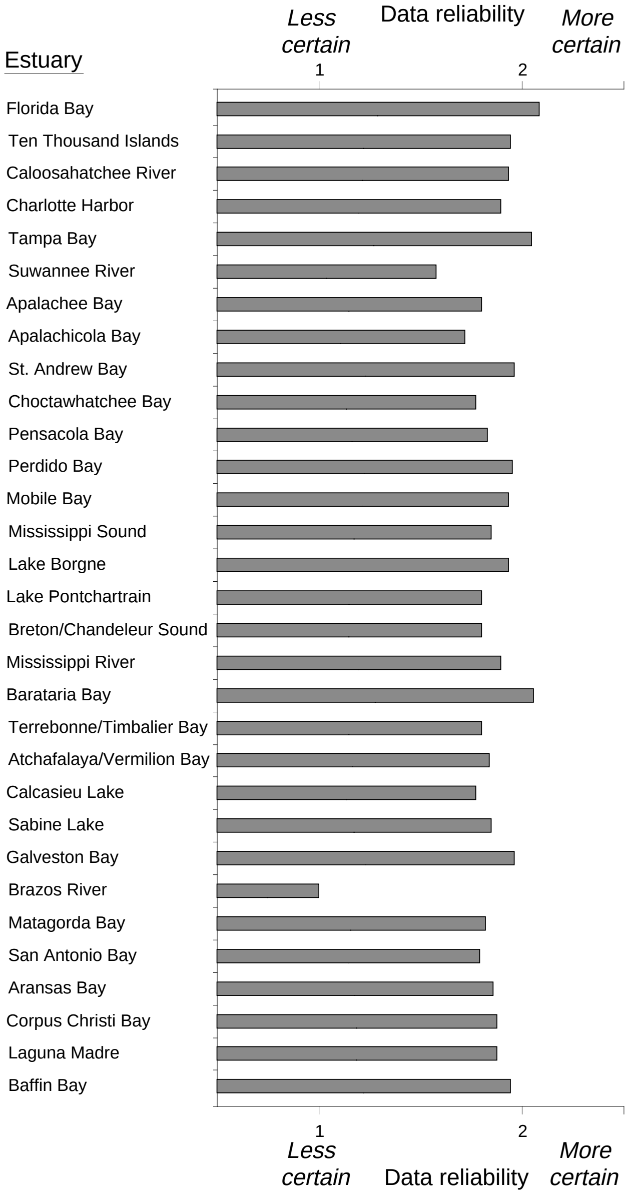

Figure 5. Mean data reliability by estuary.

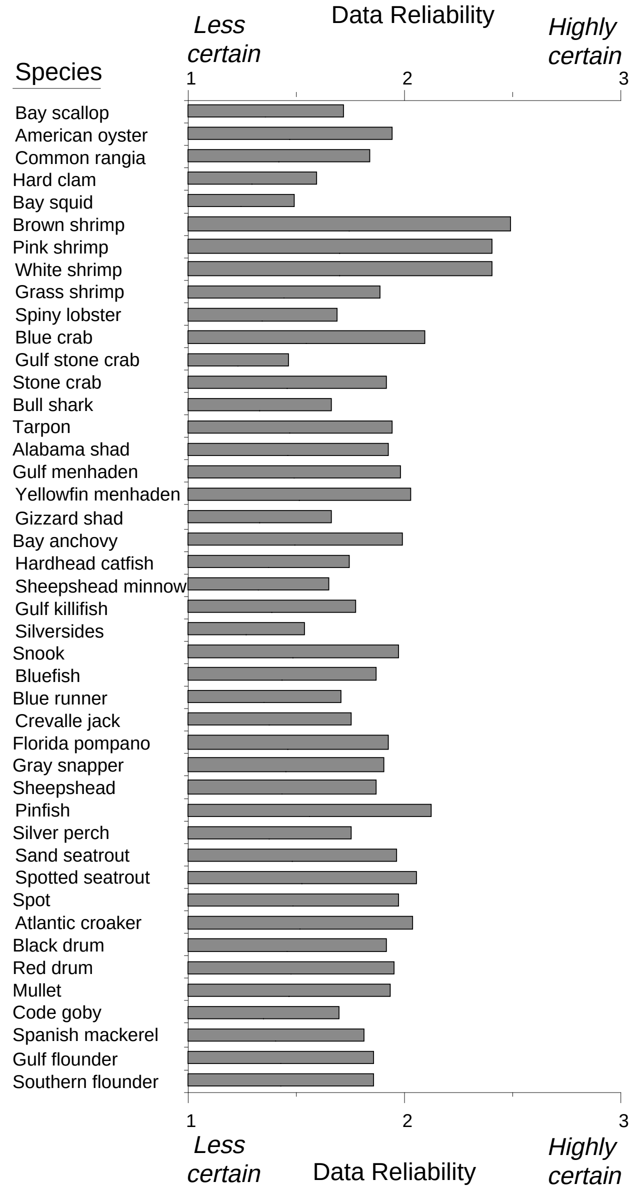

Figure 7. Mean data reliability by species.

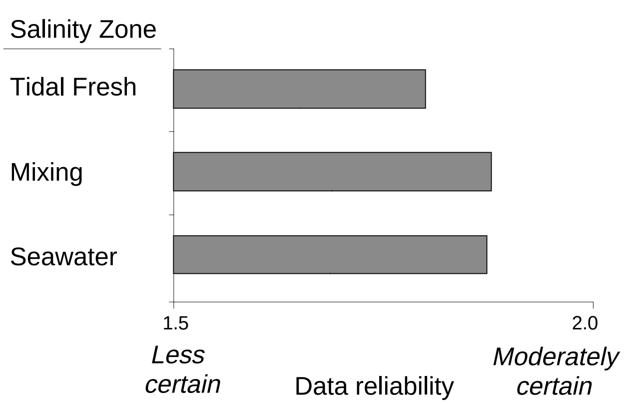

Figure 6. Mean data reliability by salinity zone.

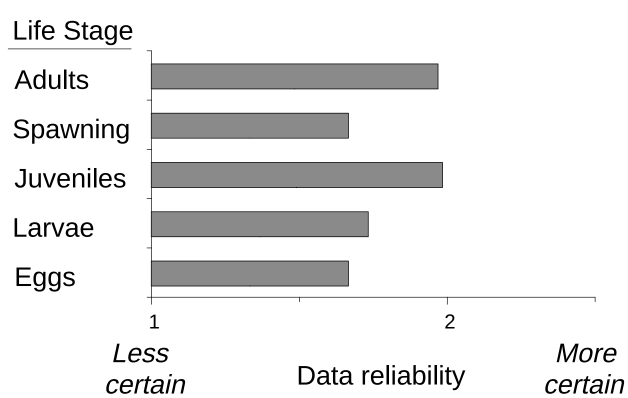

Figure 8. Mean data reliability by life stage.

they approach maturity, blue crabs seek lower salinities. Life stages considered in this report are adults, mating (instead of spawning), juveniles, larvae, and eggs.

• Stone crabs: Usually found in salinities greater than 20 ppt. Males are typically in nearshore waters, but migrate into the estuaries for mating. Life stages considered in this report are adults, mating, juveniles, larvae, and eggs. Williams and Felder (1986) have distinguished two separate species in the Gulf of Mexico. The stone crab (*Menippe mercenaria*) occurs from Florida Bay to Apalachicola Bay, and the Gulf stone crab (*M. adina*) is found from Suwannee River to the Yucatan peninsula. *M. mercenaria* is also known as Florida stone crab (Williams et al. 1989).

Fishes. Aggregating species by salinity zone uses a single fundamental habitat parameter. However, a combination of habitat characteristics, such as bottom type, water temperature, and bathymetry, would more accurately indicate species' spatial and temporal distributions. Specific habitat requirements and life history characteristics of a number of fishes are presented here:

• Bull shark: Development of eggs and larvae are internal, and parturition results in pups of juvenile size (75 cm TL). Therefore, only juveniles and adults are found in the estuaries. Fishing gear usually limits the ability to take large sharks. Based on the sizes of sharks captured, it may be inferred that parturition is occurring within the estuaries. Life stages considered in this report are adults, mating, juveniles, and parturition.

• Tarpon: Spawning, egg, and larval stages occur well off shore. Juveniles use the estuaries as a nursery ground, often seeking waters of low dissolved oxygen and low salinity.

• Alabama shad: Not found west of the Barataria Bay barrier islands in Louisiana, nor in south Florida.

• Menhaden: Juveniles are the predominant life stage utilizing the estuaries. Spawning generally occurs from the coastline to six miles offshore. Gulf menhaden (*Brevoortia patronus*) are generally not common south of Tampa Bay, and yellowfin menhaden (*Brevoortia smithi*) are generally not common north and west of Tampa Bay. The two species may hybridize where their ranges overlap.

• Gizzard shad: Large juveniles and adults are found in estuaries, but adults must return to freshwater to spawn. In large rivers there is an upstream migration or "spring run." Juveniles that are washed into bays with floods can mature to adulthood, but their upstream migration may be impeded by dams, weirs, and other waterway restrictions. Not common in south Florida estuaries.

• Bay anchovy: All life stages occur in estuaries, although adults may move offshore. This is a key forage species that is one of the most abundant fishes in Gulf of Mexico estuarine waters.

• Hardhead catfish: Eggs and larvae are brooded in the mouths of adult males; therefore, their distribution is determined by the adult population.

• Sheepshead minnow: The entire life cycle is completed within the estuary, and all life stages are euryhaline and eurythermal. This species tends to prefer open bottom to heavily vegetated areas.

• Gulf killifish: All life stages are estuarine, euryhaline, and eurythermal. This species occurs in shallow estuarine waters, including mangrove and flooded marsh habitat.

• Silversides: Two species commonly occur in Gulf of Mexico estuaries: the tidewater silverside, *Menidia peninsulae*, and inland silverside, *M. beryllina* (Chernoff et al. 1981, Robins et al. 1991). The two were formerly considered to be a single species (Robins et al. 1980). Although they do occur together and occasionally hybridize, the tidewater silverside is generally found in moderate to high salinity estuarine waters, and the inland silverside in low salinity estuarine waters and inland freshwater (Johnson 1975). These species are considered together in this report because most fisheries data do not distinguish between them. All life stages are estuarine, euryhaline, and eurythermal. Adults and juveniles form schools, primarily in shallow waters near the surface, and are often abundant.

• Snook: Also known as common snook (Robins et al. 1991). The snook is most common in the southern Florida estuaries, but also occurs in Texas. Adults and juveniles are euryhaline, but are quite sensitive to cold temperatures.

• Bluefish: Spawning, egg and larval development occur offshore. Juveniles and adults are the principal life stages found in estuaries. The bluefish is a primarily visual predator, and often schools. In the Gulf of Mexico, they are generally most common from Mississippi Sound eastward.

• Blue runner and crevalle jack: Juveniles and adults enter estuaries, but other life stages are usually offshore.

• Florida pompano: Typically found in nearshore surf and inlet waters, but juveniles and adults do enter the bays. Spawning, eggs, and larvae are typically offshore.

• Gray snapper: Juveniles are typically associated with vegetation in estuaries, particularly seagrass beds and mangroves. Adults, spawning, eggs, and larvae are usually offshore.

• Sheepshead: Spawning occurs in nearshore and inlet waters. Larvae are transported towards the estuaries, but typically enter as juveniles.

• Pinfish: Juveniles are the predominant life stage within estuaries. Adults, spawning and eggs are typically offshore. Larvae are transported to inlets, but usually attain juvenile size before they enter bays. Subadults and adults may remain in some bays before migrating offshore for spawning.

• Sciaenids: Most sciaenids move to nearshore or offshore waters for spawning, although some may spawn in passes. Larvae may be transported toward estuaries, but typically attain juvenile size before they enter. Juveniles develop in the nursery habitats of the bays, then migrate out as subadults. Since some of these species have rather long life spans, several years may be spent in the estuaries as juveniles. As temperatures drop in the winter, they move into deeper waters.

• Striped mullet: Estuarine habitat is primarily used by juveniles and adults. They spawn offshore or near passes, and larvae move inshore and into estuaries.

• Code goby: This species is usually associated with seagrasses and higher salinities.

• Spanish mackerel: Juveniles and adults enter estuaries, but other life stages are pelagic and primarily offshore.

• Flounders: Spawning, eggs, and larvae are in nearshore waters. Juveniles and larvae migrate into bays for growth and development. Juveniles and adults migrate according to temperature, creating "fall runs" to the offshore waters. Gulf flounder (*Paralichthys albigutta*) appear to be more restricted in their ascent into fresher water, typically remaining in salinities greater than 20 ppt, whereas southern flounder (*P. lethostigma*) often occur in tidal fresh water. Gulf flounder are most common from Mississippi Sound eastward to Florida, whereas southern flounder occur primarily from the Florida panhandle westward to Texas.

Life history summaries. The life history notes above assist in interpreting the data summary tables. However, because of the complex life histories of estuarine-dependent species, a concise life history summary was written for each species. Each summary provides an overview of how and when a species uses estuaries and what specific habitats it uses. The 44 life history summaries will be published as *Volume II* of *Distribution and Abundance of Fishes and Invertebrates in Gulf of Mexico Estuaries* (Pattillo et al., in prep.). They emphasize species-specific life history characteristics that relate directly to estuarine spatial and temporal distribution and abundance. Information for the species life history summaries was gathered primarily from published and unpublished literature, and individuals with species-specific knowledge were consulted. Examples of draft summaries for three Gulf of Mexico species are included in Monaco et al. (1989).

Life history tables. While the species life history summaries provide concise accounts of important life history attributes, they do not permit a direct and simple assessment of characteristics that a species shares with others. Furthermore, many life history attributes are categorical and more readily conveyed in a tabular rather than a textual format. Therefore, information from the species life history summaries has been augmented with additional physical and biological parameters and condensed into three life history tables. Major table headings are: Habitat Associations, Biological Attributes, and Reproduction. These tables present life history characteristics for each species along with behavioral traits and preferred habitats. They reflect the most current information about a species as compiled from published and unpublished literature, and can be used to quickly identify species with similar characteristics. The life history tables will be presented along with the summaries in *Volume II* (Pattillo et al., in prep.).

Use of ELMR Data

Classifying and comparing estuaries. Although the qualitative nature of the distribution data precludes statistical comparisons of species abundances among estuaries, comparisons can be made using data on the presence/absence of species in salinity zones. This information, combined with the spatial and temporal distribution data, is the strength of the data base. Estuaries can be loosely categorized by their physical and chemical characteristics and their associated species assemblages (Monaco et al. 1992). The relative importance of individual estuaries to specific species may also be determined.

The species found in an estuary are sensitive indicators of both the mean and extreme environmental conditions within that estuary. Estuaries can be classified by the number of species present and by whether the fauna are primarily marine, estuarine, or freshwater. Species assemblages may correlate with physical characteristics, such as bottom substrate, vegetation, and areal and temporal characteristics of salinity zones. The information on species presence/absence or other attributes can be used to determine the faunal similarities and differences among estuaries.

A comparison of estuaries and associated species can identify differing factors among those estuaries that might account for shifts in species distribution and relative abundance, helping to define ecological variables controlling species distributions. For example, a species may show differing salinity tolerances among estuaries, suggesting that some other factor, such as temperature, competition, or predation may be regulating its distribution.

Linkages to marine ecosystems. Estuaries are home to many aquatic species year-round, however, a large number of species only use estuaries for specific parts of their life histories and spend the rest offshore. Most of these latter species fall into four general categories: 1) diadromous species, which use estuaries as migration corridors and, in some instances, nursery areas; 2) species that use estuaries for spawning, often at specific salinities; 3) species that spawn in marine waters near the mouths of estuaries and depend on tidal- and wind-driven currents to carry eggs, larvae, or early juveniles into estuarine nursery areas; and 4) species that enter estuaries during certain times of year to feed on abundant prey. The importance of an estuary can be assessed by the intensity with which species use estuarine habitats. Importance can be estimated both by the number of species present as well as the density of specific life stages in estuaries relative to offshore habitats. These data may assist in identifying adverse effects of estuarine degradation on offshore populations.

East Coast Strategic Assessment. Development of a capability to define and interpret the effects of anthropogenic and natural phenomena on living marine resources will be a component of the Strategic Environmental Assessments Division's *East Coast of North America Strategic Assessment Project* begun in FY 92 (NOAA 1991). This project will characterize the biological, physical, chemical, and economic characteristics of the east coast of North America to address multiple resource use conflicts. The data compiled for the ELMR southeast and northeast study regions will be major components of this project. The new initiative will include electronic mapping of the distribution and relative abundance of living marine resources. The study area begins at the head-of-tide in estuaries and encompasses the continental shelf as defined by the 200-m isobath. Beyond the shelf, the study area contains epipelagic waters. The areal coverage will extend from the Straits of Belle Isle, Newfoundland, to Tampa Bay, Florida. The ELMR distribution and abundance data will be the primary source of fish and invertebrate information for east coast estuaries. These data will be integrated with the coastal and offshore living resource information to develop a consistent data base on species found from the head-of-tide to past the continental shelf. This will enhance NOAA's capability to define and understand the coupling of estuarine and marine habitats based on species' spatial and temporal distributions and life history characteristics.

Additional data sets developed or under development (e.g., National Status and Trends, O'Connor 1990) in NOAA programs will enable regional environmental assessments of anthropogenic effects on living marine resources. The integration of biological and physical data will significantly improve our ability to identify and define the biological linkages and physical interchanges between estuarine and shelf habitats. As it becomes apparent that the cumulative effects of small alterations in many estuaries have a total systemic impact on coastal ocean resources, it is more important than ever to compile consistent information on the Nation's estuarine fishes and invertebrates. Although the knowledge available to effectively conserve and manage living resources is limited, the ELMR data base provides an important tool for assessing the status of estuarine fauna and examining their relationships with other species and their environment. The ELMR data base provides baseline information on the zoogeography and ecology of estuarine fishes and invertebrates, and identifies gaps in our knowledge of these resources. When combined with data sets under development in the *East Coast of North America Strategic Assessment Project*, our ability to conduct interdisciplinary assessments that identify strategies to balance resource development and conservation efforts will be significantly enhanced.

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Data Summary Tables

In each data summary table, species are listed in a phylogenetic order, as in Table 2, p. 3. Estuaries are listed in an east to west order, as in Table 1, p. 3. At the beginning of each data summary is an index table showing the page location of each species and estuary within the data summary.

Table 3. Presence/absence* of ELMR species in Gulf of Mexico estuaries

*highest relative abundance of adults or juveniles in any salinity zone, in any month.

Estuary (Florida Bay – Lake Pontchartrain)

Species	Florida Bay	Ten Thousand Islands	Caloosahatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay	Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound	Lake Borgne	Lake Pontchartrain
Bay scallop	√	√	○	√	√		○	√	○		○			○		
American oyster		○	◉	○	○	◉	◉	◉	○	○	○	√	○	○	○	○
Common rangia			●	●	●	◉	○	◉	○	○	○	◉	◉	○	◉	◉
Hard clam				○	◉	○	○		○	○		○	√	○		
Bay squid	√	√	○	○	◉	○	○	◉	◉	○	○	○	○	●	◉	○
Brown shrimp	√	√	√	√				◉	◉	◉	●	●	●	●	●	◉
Pink shrimp	●	●	◉	◉	●	●	◉	◉	◉	◉	○	○	○	○	√	√
White shrimp						√	●	●	○	◉	◉	○	●	●	●	●
Grass shrimp	●	○	●	●	●	●	●	●	◉	◉	●		●	◉	●	○
Spiny lobster	○	√		√	√				○					√		
Blue crab	◉	◉	●	◉	◉	●	●	●	●	◉	◉	◉	●	●	●	◉
Gulf stone crab						√	○	○	√	√	√	√	○	○	√	√
Stone crab	○	○	√	○	○	○	○	√								
Bull shark	○	○	○	○	○	○	○	○	○	○	○	√	○	○	○	○
Tarpon	○	○	◉	◉	◉	○	○	○	○	○	○	√	○	○	○	○
Alabama shad						○		○	○	○			√	◉	○	√
Gulf menhaden	√	√	√	√	●	○	◉	◉	●	●	●	◉	●	●	●	●
Yellowfin menhaden	◉	●	○	○	◉		√							√	√	√
Gizzard shad						○	○	○		○	○	√	○	◉	●	○
Bay anchovy	●	●	●	●	●	●	●	●	◉	●	●	◉	●	●	●	●
Hardhead catfish	◉	○	◉	●	○	●	◉	●	●	◉	◉	◉	◉	●	●	◉
Sheepshead minnow	◉	○	○	○	●	●	●	◉	◉	◉	◉	○	◉	◉	○	○

Estuary (Breton/Chandeleur Sound – Baffin Bay)

Species	Breton/Chandeleur Sound	Mississippi River	Barataria Bay	Terrebonne/Timbalier Bay	Atchafalaya/Vermilion Bay	Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay	Corpus Christi Bay	Laguna Madre	Baffin Bay
Bay scallop	√							√		√	√	√	√	√	
American oyster	◉	√	◉	◉	◉	○	○	●	na	○	◉	○	○	√	
Common rangia	○	○	◉	◉	○	○	●	◉	na	○	√	√	√		
Hard clam	○		○	√				○	na	○	○	○	○		
Bay squid	○		○	○	○	○	√	○	○	◉	◉	○	○	○	○
Brown shrimp	◉	○	●	●	●	●	◉	●	◉	●	●	●	●	◉	●
Pink shrimp	◉		○	√	√			√	○	○	○	○	○	◉	○
White shrimp	○	○	●	◉	●	●	●	●	●	●	●	◉	◉	◉	√
Grass shrimp	◉	○	◉	◉	●	●	●	●	◉	●	◉	◉	●	●	●
Spiny lobster														√	
Blue crab	◉	○	◉	◉	◉	●	●	◉	○	◉	●	●	●	◉	◉
Gulf stone crab	○	○	○	○	√	○	√	○	na	○	○	○	○	√	○
Stone crab															
Bull shark	◉	√	○	○	○	√	√	○	na	○	○	○	○	√	√
Tarpon		○	√	√	√		√	√	na	○	○	√	√	√	√
Alabama shad	√														
Gulf menhaden	●	◉	●	◉	●	●	●	●	◉	●	◉	◉	◉	◉	●
Yellowfin menhaden															
Gizzard shad	○	◉	○	○	○	○	○	○	○	◉	○	√	○	√	◉
Bay anchovy	◉	●	●	●	●	●	◉	●	●	●	●	●	●	●	●
Hardhead catfish	◉	●	●	◉	◉	◉	○	◉	○	◉	●	◉	◉	●	●
Sheepshead minnow	○	◉	●	○	◉	◉	◉	◉	◉	◉	◉	◉	◉	●	●

Relative abundance :

● - Highly Abundant ◉ - Abundant ○ - Common √ - Rare Blank - Not present na - No data available

Table 3, continued.

Species	Florida Bay	Ten Thousand Islands	Caloosahatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay	Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound	Lake Borgne	Lake Pontchartrain	Breton/Chandeleur Sound	Mississippi River	Barataria Bay	Terrebonne/Timbalier Bay	Atchafalaya/Vermilion Bay	Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay	Corpus Christi Bay	Laguna Madre	Baffin Bay
Gulf killifish	○	◉	○	◉	○	◉	◉	○	○	○	○		◉	○	◉	○	○	◉	●	●	◉	◉	◉	◉	◉	◉	◉	◉	○	◉	◉
Silversides	●	◉	●	●	●	◉	●	●	◉	◉	◉	◉	◉	●	◉	◉	○	◉	●	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	●	●
Snook	○	◉	◉	◉	○	○	○	○											√					√		√		√	√	○	
Bluefish	○	○		○	○	○	○	○	◉	◉	○	○	○	○			√	√	○	√	√	√	√	○	○	√	√	√	√		
Blue runner	√	○		○	○	○	○	○	◉	○	○	○	○	◉					○	√				√							
Crevalle jack	◉	○	○	◉	◉	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	√	○	○	○	○	○	○	◉	○
Florida pompano	●	○		◉	○	√	○		○	○	○	○	○	◉			○	○	○	○	√	○		○		○	○	○	○	◉	√
Gray snapper	◉	○	√	○	○	○	○	√	○	○	◉	○	○				○		○	√		√		√		√	√	√	√	○	√
Sheepshead	○	○	√	√	○	○	√	○	○	○	○	◉	◉	○	◉	○	○	○	◉	◉	○	○	○	○	○	◉	◉	○	○	◉	○
Pinfish	●	●	●	●	●	●	◉	◉	●	◉	●	◉	◉	●	◉	◉	○	○	◉	◉	○	○	○	◉	◉	●	◉	◉	◉	●	◉
Silver perch	◉	◉	◉	◉	◉	◉	○	◉	◉	○	○	○	○	●	●	○	○	○	◉	◉	○	○	○	○	○	○	○	○	○	◉	◉
Sand seatrout	√	◉	●	●	◉	●	●	●	◉	◉	○	○	●	●	●	◉	○	●	◉	◉	◉	◉	√	◉	○	○	○	○	◉	√	○
Spotted seatrout	◉	○	○	◉	○	◉	○	○	◉	◉	○	○	◉	◉	◉	○	◉	◉	○	◉	◉	○	○	○	○	○	○	○	○	○	○
Spot	○	○	○	○	●	◉	●	◉	◉	●	●	◉	●	●	●	○	◉	◉	●	◉	◉	○	◉	◉	◉	◉	◉	◉	◉	●	●
Atlantic croaker	√	√	√	○	√	○	○	●	◉	◉	●	○	●	●	●	●	◉	●	●	●	●	●	◉	●	●	●	●	◉	◉	◉	◉
Black drum	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	○	◉	◉	○	○	○	○	○	○	○	○	○	○	◉
Red drum	○	√	◉	◉	●	○	○	○	◉	○	○	○	○	○	◉	○	◉	○	○	○	○	◉	○	○	○	○	○	○	○	○	○
Striped mullet	●	●	●	●	●	◉	●	◉	●	◉	◉	◉	◉	●	●	◉	◉	◉	◉	◉	◉	◉	○	◉	○	◉	◉	◉	◉	◉	◉
Code goby	●	●	◉	●	◉	○	○	○	◉	○	○	√		○	◉	○			√					√	na	○	√	○	○	◉	◉
Spanish mackerel	○	○	√	○	○	○	√	√	◉	○	○	◉	○	◉	√	√	○	√	○	○	○	○	○	○	√	√	√	√	√	√	
Gulf flounder	○	○	√	○	○	○	○	○	◉	○	○	○	○	○										√		√	√	√	√	√	√
Southern flounder	√	√		√	√	○	○	○	○	○	○	○	○	◉	○	○	◉	◉	◉	◉	○	◉	●	●	○	◉	◉	○	○	◉	○

Relative abundance :

● - Highly Abundant ◉ - Abundant ○ - Common √ - Rare Blank - Not present na - No data available

Table 4. Spatial distribution and relative abundance

Index to Table 4. Page location of spatial distribution table for each species and estuary.

Common and Scientific Name	Estuary: Florida Bay, Ten Thousand Islands, Caloosahatchee River, Charlotte Harbor, Tampa Bay, Suwannee River, Apalachee Bay	Apalachicola Bay, St. Andrew Bay, Choctawhatchee Bay, Pensacola Bay, Perdido Bay, Mobile Bay, Mississippi Sound	Lake Borgne, Breton/Chandeleur Sound, Lake Pontchartrain, Mississippi River, Barataria Bay, Terrebonne/Timbalier Bay, Atchafalaya/Vermilion Bay	Calcasieu Lake, Sabine Lake, Galveston Bay, Brazos River, Matagorda Bay, San Antonio Bay, Aransas Bay	Corpus Christi Bay, Laguna Madre, Baffin Bay
Bay scallop (*Argopecten irradians*) American oyster (*Crassostrea virginica*) Common rangia (*Rangia cuneata*) Hard clam (*Mercenaria* species) Bay squid (*Lolliguncula brevis*) Brown shrimp (*Penaeus aztecus*)	20	21	22	23	24
Pink shrimp (*Penaeus duorarum*) White shrimp (*Penaeus setiferus*) Grass shrimp (*Palaemonetes pugio*) Spiny lobster (*Panulirus argus*) Blue crab (*Callinectes sapidus*) Gulf stone crab (*Menippe adina*)	25	26	27	28	29
Stone crab (*Menippe mercenaria*) Bull shark (*Carcharhinus leucas*) Tarpon (*Megalops atlanticus*) Alabama shad (*Alosa alabamae*) Gulf menhaden (*Brevoortia patronus*) Yellowfin menhaden (*Brevoortia smithi*)	30	31	32	33	34
Gizzard shad (*Dorosoma cepedianum*) Bay anchovy (*Anchoa mitchilli*) Hardhead catfish (*Arius felis*) Sheepshead minnow (*Cyprinodon variegatus*) Gulf killifish (*Fundulus grandis*) Silversides (*Menidia* species)	35	36	37	38	39
Snook (*Centropomus undecimalis*) Bluefish (*Pomatomus saltatrix*) Blue runner (*Caranx crysos*) Crevalle jack (*Caranx hippos*) Florida pompano (*Trachinotus carolinus*) Gray snapper (*Lutjanus griseus*)	40	41	42	43	44
Sheepshead (*Archosargus probatocephalus*) Pinfish (*Lagodon rhomboides*) Silver perch (*Bairdiella chrysoura*) Sand seatrout (*Cynoscion arenarius*) Spotted seatrout (*Cynoscion nebulosus*) Spot (*Leiostomus xanthurus*)	45	46	47	48	49
Atlantic croaker (*Micropogonias undulatus*) Black drum (*Pogonias cromis*) Red drum (*Sciaenops ocellatus*) Striped mullet (*Mugil cephalus*) Code goby (*Gobiosoma robustum*) Spanish mackerel (*Scomberomorus maculatus*)	50	51	52	53	54
Gulf flounder (*Paralichthys albigutta*) Southern flounder (*Paralichthys lethostigma*)	55	56	57	58	59

Table 4. Spatial distribution and relative abundance

Species/Life Stage		Florida Bay			Ten Thousand Islands			Caloosa-hatchee River			Charlotte Harbor			Tampa Bay			Suwannee River			Apalachee Bay		
		Gulf of Mexico Estuaries																				
		T	M	S	T	M	S	T	M	*	T	M	S	T	M	S	T	M	S	T	M	S
Bay scallop	A		√	√		√	√		○			√	√		√	√					√	○
	S		√	√		√	√		○			√	√		√	√					√	○
Argopecten irradians	J		√	√		√	√		○			√	√		√	√					√	○
	L		√	√		√	√		○			√	√		√	√					√	○
	E		√	√		√	√		○			√	√		√	√					√	○
American oyster	A					○	○	√	◉			○	○		○	○		◉	◉		◉	◉
	S					○	○		○			○	○		○	○		◉	◉		◉	◉
Crassostrea virginica	J					○	○	√	○			○	○		○	○		◉	◉		◉	◉
	L					○	○		○			○	○		○	○		◉	◉		◉	◉
	E					○	○		○			○	○		○	○		◉	◉		◉	◉
Common rangia	A							●	●		●	●		●	●		○	◉		○	○	
	S							●	●		●	●		●	●			◉			○	
Rangia cuneata	J							●	●		●	●		●	●		○	◉		○	○	
	L							●	●		●	●		●	●			◉		○	○	
	E							●	●		●	●		●	●			◉			○	
Hard clam	A												○			○			○			○
	S												○			○			○			○
Mercenaria species	J												○			◉			○			○
	L												○			○			○			○
	E												○			○			○			○
Bay squid	A		√	√		√	√		○			○	○		◉	◉		○	○		○	○
	S		√	√		√	√		○			○	○		◉	◉		○	○		○	○
Lolliguncula brevis	J		√	√		√	√		○			○	○		◉	◉		○	○		○	○
	L		√	√		√	√		○			○	○		◉	◉		○	○		○	○
	E		√	√		√	√		○			○	○		◉	◉		○	○		○	○
Brown shrimp	A		√	√		√	√					√	√									
	S																					
Penaeus aztecus	J		√	√		√	√		√			√	√									
	L		√	√		√	√					√	√									
	E																					

T M S T M S T M * T M S T M S T M S T M S
Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Apalachicola Bay			St. Andrew Bay			Choctawhatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
Species/Life Stage		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
Bay scallop	A		√	√		○	○					○	○								○	○
	S		√	√		○	○														○	○
Argopecten irradians	J		√	√		○	○					○									○	○
	L		√	√		○	○														○	○
	E		√	√		○	○														○	○
American oyster	A		◉	◉		○	√		○	√		○	√			√		○	○		○	√
	S		◉	◉		○	√		○	√		○	√			√		○	○		●	●
Crassostrea virginica	J		◉	◉		○	√		○	√		○	√			√		○	○		○	√
	L		◉	◉		○	√		○	√		○	√			√		○	○		●	√
	E		◉	◉		○	√		○	√		○	√			√		○	○		●	○
Common rangia	A	○	◉		○	○		√	○		○	○		○	◉		◉	◉			○	
	S		◉			○			○			○			◉			◉			○	
Rangia cuneata	J	○	◉		○	○		√	○		○	○		○	◉		√	◉			○	
	L	○	◉		√	○		√	○		○	○			◉		√	◉			○	
	E		◉			○			○			○			◉			◉			○	
Hard clam	A						○			○					○	○		√	√		√	○
	S						○			○					√	√		√	√		√	○
Mercenaria species	J						○			○					√	√		√	√		√	○
	L						○			○					√	√		√	√		√	○
	E						○			○					√	√		√	√		√	○
Bay squid	A		◉	◉		○	◉		○	○		○	○		○	○		○	○		●	●
	S		◉	◉		○	○		○	○		○	○		○	○		○	○		◉	●
Lolliguncula brevis	J		◉	◉		○	◉		○	○		○	○		○	○		○	○		●	●
	L		◉	◉		○	○		○	○		○	○		○	○		○	○		○	●
	E		◉	◉		○	○		○	○		○	○		○	○		○	○		○	◉
Brown shrimp	A		◉	◉		◉	◉		◉	◉		●	●		●	●		●	●	√	●	●
	S																					○
Penaeus aztecus	J	◉	◉	◉		◉	◉	◉	◉	◉	●	●	●	●	●	●	●	●	●	√	●	●
	L		◉	◉		◉	◉		◉	◉		●	●		√	√		●	●	○	●	●
	E																					◉
		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
		Apalachicola Bay			St. Andrew Bay			Choctawhatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
		Gulf of Mexico Estuaries																				

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Lake Borgn			Lake Pontchar-train			Breton/ Chandeleur Sounds			Mississippi River			Barataria Bay			Terrebonne/ Timbalier Bays			Atchafalaya/ Vermilion Bays		
Species/Life Stage		T	M	*	*	M	*	*	M	S	T	M	*	T	M	S	T	M	S	T	M	*
Bay scallop	A									√												
	S									√												
Argopecten irradians	J									√												
	L									√												
	E									√												
American oyster	A		○			○			◉	◉		√		√	◉	○	√	◉	○		◉	
	S		○			○			◉	◉		√			◉	○		◉	○		◉	
Crassostrea virginica	J		○			○			◉	◉		√		√	◉	○	√	◉	○		◉	
	L		○			○			◉	◉		√			◉	○		◉	○		●	
	E		○			○			◉	◉		√			◉	○		◉	○		◉	
Common rangia	A	◉	◉			◉			○		○	○		◉	◉		◉	○			○	
	S	◉	◉			◉			○		○	○		◉	○		◉	○			○	
Rangia cuneata	J	◉	◉			◉			○		○	○		◉	◉		◉	○			○	
	L	◉	◉			◉			○		○	○		◉	○		◉	○			○	
	E	◉	◉			◉			○		○	○		◉	○		◉	○			○	
Hard clam	A								○	○					○	○		√	√			
	S									○					○	○			√			
Mercenaria species	J								○	○					○	○		√	√			
	L									○					○	○			√			
	E									○					○	○			√			
Bay squid	A		◉			○			○	○					○	○		○	○		○	
	S																					
Lolliguncula brevis	J		◉			○			○	○					○	○		○	○		○	
	L																					
	E																					
Brown shrimp	A		◉			○																
	S																					
Penaeus aztecus	J	√	●			◉			◉	○		○		○	●	●	○	●	●	√	●	
	L		●			○									●	●					◉	
	E																					

T M * * M * * M S T M * T M S T M S T M *
Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays
Gulf of Mexico Estuaries

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity zone not present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Calcasieu Lake			Sabine Lake			Galveston Bay			Brazos River			Matagorda Bay			San Antonio Bay			Aransas Bay		
Species/Life Stage		T	M	*	T	M	*	T	M	S	T	M	*	T	M	S	*	M	S	*	M	S
Bay scallop	A									√					√	√		√	√		√	√
	S									√						√			√		√	√
Argopecten irradians	J									√					√	√		√	√		√	√
	L									√						√			√		√	√
	E									√						√			√		√	√
American oyster	A		○		√	○		√	◉	√	na	na		√	○	√		◉	√		○	√
	S		○			○			◉	√	na	na			○			◉	√		○	√
Crassostrea virginica	J		○		√	○		√	●	√	na	na		√	○	√		◉	√		○	√
	L		○		√	○		√	◉	√	na	na		√	○	√		◉	√		○	√
	E		○			○			◉	√	na	na			○			◉	√		○	√
Common rangia	A	√	○		√	●		◉	○		na	na		○	○			√			√	
	S	√	○		√	●		◉	○		na	na		○	○			√			√	
Rangia cuneata	J	√	○		√	●		◉	○		na	na		○	○			√			√	
	L	√	○		√	●		◉	○		na	na		○	○			√			√	
	E	√	○		√	●			○		na	na		○	○			√			√	
Hard clam	A								√	○		na			√	○		√	○		○	○
	S								√	○		na			√	○		√	○		○	○
Mercenaria species	J								√	○		na			√	○		√	○		○	○
	L								√	○		na			√	○		√	○		○	○
	E								√	○		na			√	○		√	○		○	○
Bay squid	A		○			√			○	○		○			○	◉		○	◉		○	○
	S								○	○		na			○	◉		○	◉		○	○
Lolliguncula brevis	J		○			√			○	○		○			○	◉		○	◉		○	○
	L								○	○		na			○	◉		○	◉		○	○
	E								○	○		na			○	◉		○	◉		○	○
Brown shrimp	A				√	√									○	●		○	◉			
	S																					
Penaeus aztecus	J	○	●		○	◉		◉	●	◉	na	◉		○	●	○		●	○		●	◉
	L		◉			◉			○	●	na	◉		○	●	●		●	●		◉	◉
	E																					

T M * T M * T M S T M * T M S * M S * M S
Calcasieu Lake Sabine Lake Galveston Bay Brazos River Matagorda Bay San Antonio Bay Aransas Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present
- na No Data Available

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay *	Corpus Christi Bay M	Corpus Christi Bay S	Laguna Madre *	Laguna Madre *	Laguna Madre S	Baffin Bay *	Baffin Bay *	Baffin Bay S
Bay scallop	A		√	√			√			
	S		√	√			√			
Argopecten irradians	J		√	√			√			
	L		√	√			√			
	E		√	√			√			
American oyster	A		○	√			√			
	S		○	√			√			
Crassostrea virginica	J		○	√			√			
	L		○	√			√			
	E		○	√			√			
Common rangia	A		√							
	S		√							
Rangia cuneata	J		√							
	L		√							
	E		√							
Hard clam	A		○	○						
	S		○	○						
Mercenaria species	J		○	○						
	L		○	○						
	E		○	○						
Bay squid	A		○	○			○			○
	S		○	○			○			
Lolliguncula brevis	J		○	○			○			○
	L		○	○			○			
	E		○	○			○			
Brown shrimp	A						○			
	S									
Penaeus aztecus	J		●	○			◉			●
	L		○	○			√			
	E									

Relative Abundance		Salinity Zone	Life Stage
●	Highly Abundant	T - Tidal Fresh	A - Adults
◉	Abundant	M - Mixing	S - Spawning adults
○	Common	S - Seawater	J - Juveniles
√	Rare	* - Salinity zone not present	L - Larvae
Blank	Not Present		E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Florida Bay			Ten Thousand Islands			Caloosa-hatchee River			Charlotte Harbor			Tampa Bay			Suwannee River			Apalachee Bay		
Species/Life Stage		T	M	S	T	M	S	T	M	*	T	M	S	T	M	S	T	M	S	T	M	S
Pink shrimp	A															√						
	S																					
Penaeus duorarum	J		●	●		◉	●		◉			◉	◉		●	●		●	◉		◉	◉
	L		●	●		◉	●								●	●			○			○
	E																					
White shrimp	A																	√	√		√	◉
	S																					
Penaeus setiferus	J																	√	√	○	●	◉
	L																		√			
	E																					
Grass shrimp	A	√	●	◉	√	○	○	○	●		√	●	◉		●	◉	√	●	◉	√	●	◉
	S		●	◉		○	○		●			●	◉		●	◉		●	◉		●	◉
Palaemonetes pugio	J	√	●	◉	√	○	○		●		√	●	◉		●	◉	√	●	◉	√	●	◉
	L		●	◉		○	○		●			●	◉		●	◉		●	◉		●	◉
	E		●	◉		○	○		●			●	◉		●	◉		●	◉		●	◉
Spiny lobster	A			√									√			√						
	M																					
Panulirus argus	J			○			√						√			√						
	L																					
	E																					
Blue crab	A	○	◉	◉	√	◉	◉	√	◉			◉	○		◉	○	○	●	●	○	●	●
	M	○	◉		√	◉			◉			◉			◉		○	●		○	●	
Callinectes sapidus	J	○	◉	○	√	◉	○	◉	●			◉	√		◉	√	○	●	○	○	●	○
	L		√	◉		√	◉					√	◉		√	◉		√	●		√	●
	E			√			√					○	◉		○	◉		◉	◉		◉	◉
Gulf stone crab	A																	√	√		○	√
	M																	√	√		○	√
Menippe adina	J																	√	√		○	√
	L																	√	√		○	√
	E																	√	√		○	√

T M S T M S T M * T M S T M S T M S T M S
Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity zone not present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Apalachicola Bay			St. Andrew Bay			Choctawhatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
Species/Life Stage		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
Pink shrimp	A		√	√	√	◉	◉		√	√		√	√		○	○		√	√		○	○
	S																					○
Penaeus duorarum	J		◉	◉	√	◉	◉	√	◉	◉		○	○		○	○		○	○		○	○
	L			○		√	√		√	√		√	○		√	√		√	√		○	○
	E																					○
White shrimp	A		√	◉	√	○	○	√	○	○	√	○	○		√	○	√	○	○	√	◉	●
	S																					○
Penaeus setiferus	J	○	●	◉	√	○	○	√	◉	◉	√	◉	○		○	○	◉	●	●	√	●	●
	L			√																√	◉	○
	E																					○
Grass shrimp	A	√	●	◉	√	◉	◉	√	◉	◉	√	◉	●				√	●	●	○	◉	○
	S		●	◉		◉	◉		◉	◉		◉	●					●	●	√	○	○
Palaemonetes pugio	J	√	●	◉	√	◉	◉	√	◉	◉	√	◉	●				√	●	●	√	○	○
	L		●	◉		◉	◉		◉	◉		◉	●					●	●	√	○	○
	E		●	◉		◉	◉		◉	◉		◉	●					●	●	√	○	○
Spiny lobster	A						○															
	M																					
Panulirus argus	J																					√
	L																					√
	E																					√
Blue crab	A	○	●	●	○	◉	●	√	◉	○	√	◉	○	√	◉	◉	√	●	●	√	●	●
	M	○	●		○	◉			◉			◉		√	○	○	√	●			◉	●
Callinectes sapidus	J	○	●	○	○	●	●	√	◉	○	√	◉	○	○	◉	◉	○	●	●	○	●	○
	L		√	●		√	◉		√	◉		√	◉		√	○		√	●	√	●	●
	E		◉	◉			○			√			√			○			√		◉	●
Gulf stone crab	A		○	○		√	√		√	√		√	√		√	√		○	○		○	○
	M		○	○		√	√		√	√		√	√		√	√		√	√		○	○
Menippe adina	J		○	○		√	√		√	√		√	√		√	√		○	○		○	○
	L		○	○		√	√		√	√		√	√		√	√		√	√		○	○
	E		○	○		√	√		√	√		√	√		√	√		√	√		○	○

T M S T M S T M S T M S T M S T M S T M S
Apalachicola Bay | St. Andrew Bay | Choctawhatchee Bay | Pensacola Bay | Perdido Bay | Mobile Bay | Mississippi Sound
Gulf of Mexico Estuaries

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Lake Borgn			Lake Pontchar-train			Breton/ Chandeleur Sounds			Mississippi River			Barataria Bay			Terrebonne/ Timbalier Bays			Atchafalaya/ Vermilion Bays		
Species/Life Stage		T	M	*	*	M	*	*	M	S	T	M	*	T	M	S	T	M	S	T	M	*
Pink shrimp	A								○	○												
	S																					
Penaeus duorarum	J		√			√			○	◉					○	○		√	√		√	
	L														○	○						
	E																					
White shrimp	A		◉			◉				○					◉	○		○	○	○	◉	
	S									○												
Penaeus setiferus	J	◉	●			●			○		○	○		○	●	●	○	◉	◉	○	●	
	L									○	○	○			◉	●			○		◉	
	E									○						√						
Grass shrimp	A	√	●			○			○	◉	○	○		◉	◉	◉	◉	◉	◉	●	●	
	S		●			○			○	◉	○	○		◉	◉	◉	◉	◉	◉	●	●	
Palaemonetes pugio	J	√	●			○			○	◉	○	○		◉	◉	◉	◉	◉	◉	●	●	
	L		●			○			○	◉	○	○		◉	◉	◉	◉	◉	◉	●	●	
	E		●			○			○	◉	○	○		◉	◉	◉	◉	◉	◉	●	●	
Spiny lobster	A																					
	M																					
Panulirus argus	J																					
	L																					
	E																					
Blue crab	A	●	●			◉			◉	◉	○	○		○	◉	○	○	◉	◉	○	◉	
	M	○	●			○			◉	○	○	○		○	○		○	◉		○	◉	
Callinectes sapidus	J	√	●			○			◉	◉	○	○		○	◉	○	○	◉	○	○	◉	
	L		●			√			◉	◉		○			◉	◉		○	●		◉	
	E		●						○	◉		○			○	◉		◉	◉			
Gulf stone crab	A		√			√			○	○		○			√	√		√	○		√	
	M									○												
Menippe adina	J		√			√			○	○		○			○	○		√	○		√	
	L									○												
	E									○												

T M * * M * * M S T M * T M S T M S T M *
Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs
- M - Mating

Table 4, continued. Spatial distribution and relative abundance

Species/Life Stage		Gulf of Mexico Estuaries																				
		Calcasieu Lake			Sabine Lake			Galveston Bay			Brazos River			Matagorda Bay			San Antonio Bay			Aransas Bay		
		T	M	*	T	M	*	T	M	S	T	M	*	T	M	S	*	M	S	*	M	S
Pink shrimp	A								√	√					○	○		○	○		○	
	S																					
Penaeus duorarum	J								√	√	na	○			√	√		○	○		○	○
	L																					
	E																					
White shrimp	A	○	○		◉	●			○	○	na	○		√	◉	○		●	●		○	○
	S																					
Penaeus setiferus	J	○	●		●	●		●	●	◉	●	●		●	◉	○		●	○		◉	○
	L		●			●		○	◉	●	◉	◉		●	●	●		●	●			○
	E																					
Grass shrimp	A	◉	●		◉	●		○	●	◉	na	◉		●	●	●		◉	○		◉	◉
	S	◉	●		◉	●		○	●	◉	na	◉		●	●	●		◉	○		◉	◉
Palaemonetes pugio	J	◉	●		◉	●		○	●	◉	na	◉		●	●	●		◉	○		◉	◉
	L	◉	●		◉	●		○	●	◉	na	◉		●	●	●		◉	○		◉	◉
	E	◉	●		◉	●		○	●	◉	na	◉		●	●	●		◉	○		◉	◉
Spiny lobster	A																					
	M																					
Panulirus argus	J																					
	L																					
	E																					
Blue crab	A	○	●		●	●		◉	◉	◉	na	○		○	◉	○		●	○		◉	○
	M	○	○		◉	◉		○	○			○		○	√			○			○	
Callinectes sapidus	J	○	●		◉	◉		◉	◉	◉	na	○		○	◉	○		●	√		◉	●
	L		○			◉			◉	◉		○		●	◉	○			●		○	○
	E								◉	◉		○			√	○			●			○
Gulf stone crab	A		√			√			√	○		na			○	○		○	○		○	○
	M									○						○			○			○
Menippe adina	J		○			√			√	○		na			○	○		○	○		○	○
	L									○						○			○			○
	E									○						○			○			○

T M * T M * T M S T M * T M S * M S * M S
Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present
- n No Data Available

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs
- M - Mating

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries								
		Corpus Christi Bay			Laguna Madre			Baffin Bay		
Species/Life Stage		*	M	S	*	*	S	*	*	S
Pink shrimp	A						○			√
	S									
Penaeus duorarum	J		○	○			◉			○
	L									
	E									
White shrimp	A		○	◉			○			√
	S									
Penaeus setiferus	J		◉	◉			◉			√
	L						√			
	E									
Grass shrimp	A		●	◉			●			●
	S		●	◉			●			●
Palaemonetes pugio	J		●	◉			●			●
	L		●	◉			●			●
	E		●	◉			●			●
Spiny lobster	A						√			
	M									
Panulirus argus	J						√			
	L									
	E									
Blue crab	A		○	◉			◉			◉
	M		○				○			
Callinectes sapidus	J		○	●			◉			◉
	L		○	◉			◉			○
	E			◉			◉			○
Gulf stone crab	A		○	○			√			○
	M			○			√			○
Menippe adina	J		○	○			√			○
	L			○			√			○
	E			○			√			○

		*	M	S	*	*	S	*	*	S
		Corpus Christi Bay			Laguna Madre			Baffin Bay		
		Gulf of Mexico Estuaries								

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity zone not present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Florida Bay			Ten Thousand Islands			Caloosa-hatchee River			Charlotte Harbor			Tampa Bay			Suwannee River			Apalachee Bay		
Species/Life Stage		T	M	S	T	M	S	T	M	*	T	M	S	T	M	S	T	M	S	T	M	S
Stone crab	A		√	○		○	○					○	○		√	○		√	○		√	○
	M		√	○		○	○					○	○		√	○		√	○		√	○
Menippe mercenaria	J		√	√		√	○		√			○	○		√	○		√	○		√	○
	L		√	√		√	○		√			○	○		√	○		√	○		√	○
	E		√	○		○	○					○	○		√	○		√	○		√	○
Bull shark	A	√	√	√	○	○	○	○	○		○	○	○	○	○	○	○	○	○	○	○	○
	M			√			√						√			√			√			√
Carcharhinus leucas	J	√	○	√	○	○	√	○	○		○	○	○	○	○	○	○	○	○	○	○	○
	P	√	√	√	○	○	○	√	○		√	○	○	√	○	○	○	○	○	○	○	○
Tarpon	A	√	○	○	√	○	○	◉	◉		○	◉	◉	√	○	◉	√	√	○	○		○
	S												◉									
Megalops atlanticus	J	○	○	○	○	○	○	◉	◉		◉	◉	◉	√	○	○	○	○	○	○	○	○
	L							√	√				○			√			○			○
	E																					
Alabama shad	A																○	○	○			
	S																○					
Alosa alabamae	J																○	○	○			
	L																○	○				
	E																○					
Gulf menhaden	A														●	●		√	√		◉	◉
	S																					
Brevoortia patronus	J			√		√	√		√			√	√		●	●	√	○	○	○	◉	○
	L															√			○			◉
	E																					
Yellowfin menhaden	A											○	○		◉	◉					√	√
	S																					
Brevoortia smithi	J	○	◉	◉		◉	●	○	○		○	○	○	○	◉	◉					√	√
	L		○	◉		◉	◉		√			√	○									√
	E																					

T M S T M S T M * T M S T M S T M S T M S
Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs
- M - Mating
- P - Parturition

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Apalachi-cola Bay			St. Andrew Bay			Choctaw-hatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
Species/Life Stage		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
Stone crab	A		√	√																		
	M		√	√																		
Menippe mercenaria	J		√	√																		
	L		√	√																		
	E		√	√																		
Bull shark	A	○	○	○	○	○	○	○	○	○	○	○	○	√	√	√	○	○	○	○	○	○
	M			√			√			√			√			√			√			○
Carcharhinus leucas	J	○	○	○	○	○	○	○	○	○	○	○	○	√	√	√	○	○	○	○	○	○
	P	○	○	○	○	○	○	○	○	○	○	○	○	√	√	√	○	○	○			
Tarpon	A	○	○	○		○	○	○	○	○		○	○			√		○	○		√	○
	S																					○
Megalops atlanticus	J	○	○	○	√	√	√	○	○	○	√	○	○			√		○	○	√	√	○
	L			○			○			○		○	○						○		√	○
	E																					○
Alabama shad	A	○	○	○	○	○	○	○	○	○							√	√		◉	○	√
	S	○																		◉		
Alosa alabamae	J	○	○	○	○	○	○	○	○	○							√	√		◉	○	√
	L	○																		◉		
	E	○																		◉		
Gulf menhaden	A		◉	◉	√	◉	◉		◉	◉	√	◉	◉	√	○	○	√	●	●		●	●
	S																					◉
Brevoortia patronus	J	○	◉	○	○	●	◉	○	●	○	◉	●	◉	○	◉	◉	◉	●	●	●	●	◉
	L			◉		○	○		◉	●		○	○		○	○		●	●		●	◉
	E															√			●			◉
Yellowfin menhaden	A																					√
	S																					
Brevoortia smithi	J																					
	L																					
	E																					
		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
		Apalachi-cola Bay			St. Andrew Bay			Choctaw-hatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
		Gulf of Mexico Estuaries																				

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs
- M - Mating
- P - Parturition

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Lake Borgn			Lake Pontchartrain			Breton/ Chandeleur Sounds			Mississippi River			Barataria Bay			Terrebonne/ Timbalier Bays			Atchafalaya/ Vermilion Bays		
Species/Life Stage		T	M	*	*	M	*	*	M	S	T	M	*	T	M	S	T	M	S	T	M	*
Stone crab	A																					
Menippe mercenaria	M																					
	J																					
	L																					
	E																					
Bull shark	A	○	○			○			○	◉	√	√		√	√	○	√	○	○			
Carcharhinus leucas	M																					
	J	○	○			○			○	○	√	√		√	√	√	√	○	○	√	○	
	P								○	○				√	√	√	√	√	√			
Tarpon	A	√	○			○						○				√		√	√		√	
Megalops atlanticus	S																					
	J	√	○			○										√						
	L	√	√																			
	E																					
Alabama shad	A	○	○						√													
Alosa alabamae	S																					
	J	○	○			√																
	L																					
	E																					
Gulf menhaden	A	◉	●															◉	◉			
Brevoortia patronus	S																					
	J	◉	●			●			●	◉		◉		○	◉	●	○	◉	◉	●	●	
	L		●			◉									○	○				○	○	
	E																					
Yellowfin menhaden	A		√			√																
Brevoortia smithi	S																					
	J		√			√																
	L																					
	E																					
		T	M	*	*	M	*	*	M	S	T	M	*	T	M	S	T	M	S	T	M	*
		Lake Borgn			Lake Pontchartrain			Breton/ Chandeleur Sounds			Mississippi River			Barataria Bay			Terrebonne/ Timbalier Bays			Atchafalaya/ Vermilion Bays		
		Gulf of Mexico Estuaries																				

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity zone not present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating
P - Parturition

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Calcasieu Lake			Sabine Lake			Galveston Bay			Brazos River			Matagorda Bay			San Antonio Bay			Aransas Bay		
Species/Life Stage		T	M	*	T	M	*	T	M	S	T	M	*	T	M	S	*	M	S	*	M	S
Stone crab	A																					
	M																					
Menippe mercenaria	J																					
	L																					
	E																					
Bull shark	A	√	√							√												
	M																					
Carcharhinus leucas	J	√	√		√	√		√	○	√	na	na		○	○	○		○	○		○	○
	P	√	√																			
Tarpon	A								√	√						○		√	○		√	√
	S																					
Megalops atlanticus	J					√			√	√	na	na		√	√	○		√	○		√	√
	L																					√
	E																					
Alabama shad	A																					
	S																					
Alosa alabamae	J																					
	L																					
	E																					
Gulf menhaden	A				○	○									◉	●		○	○			
	S																					
Brevoortia patronus	J	○	●		●	●		○	●	◉	na	◉		●	●	●		◉	○		◉	◉
	L	○	◉																			◉
	E																					
Yellowfin menhaden	A																					
	S																					
Brevoortia smithi	J																					
	L																					
	E																					

T M * T M * T M S T M * T M S * M S * M S
Calcasieu Lake Sabine Lake Galveston Bay Brazos River Matagorda Bay San Antonio Bay Aransas Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present
- n No Data Available

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs
- M - Mating
- P - Parturition

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries								
		Corpus Christi Bay			Laguna Madre			Baffin Bay		
Species/Life Stage		*	M	S	*	*	S	*	*	S
Stone crab *Menippe mercenaria*	A									
	M									
	J									
	L									
	E									
Bull shark *Carcharhinus leucas*	A									
	M									
	J		○	○			√			√
	P									
Tarpon *Megalops atlanticus*	A		√	√			√			
	S									
	J		√	√			√			√
	L			√						
	E									
Alabama shad *Alosa alabamae*	A									
	S									
	J									
	L									
	E									
Gulf menhaden *Brevoortia patronus*	A		○	○			○			√
	S									
	J		◉	◉			◉			●
	L			○						√
	E									
Yellowfin menhaden *Brevoortia smithi*	A									
	S									
	J									
	L									
	E									

* M S * * S * * S
Corpus Christi Bay | Laguna Madre | Baffin Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs
- M - Mating
- P - Parturition

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Florida Bay			Ten Thousand Islands			Caloosa-hatchee River			Charlotte Harbor			Tampa Bay			Suwannee River			Apalachee Bay		
Species/Life Stage		T	M	S	T	M	S	T	M	*	T	M	S	T	M	S	T	M	S	T	M	S
Gizzard shad	A																○	√		○	√	
	S																○			○		
Dorosoma cepedianum	J																○	√		○	√	
	L																○			○		
	E																○			○		
Bay anchovy	A	◉	●	●	○	●	●	◉	●		◉	●	●	◉	●	●	○	◉	●	○	●	◉
	S		●	●		●	●		●			●	●		●	●		◉	●		●	◉
Anchoa mitchilli	J	◉	●	●	○	●	●	◉	●		◉	●	●	◉	●	●	○	◉	●	○	●	◉
	L		●	●		●	●	√	●			●	●		●	●		◉	●		●	◉
	E		●	●		●	●		●			●	●		●	●		◉	●		●	◉
Hardhead catfish	A	○	○	◉	○	○	○	○	◉		○	◉	◉	○	○	○	●	●	○	○	◉	◉
	S		○	◉		○	○		◉			◉	◉		○	○		○	○		◉	◉
Arius felis	J	○	○	◉	○	○	○	○	◉		○	●	◉	○	○	○	◉	◉	○	○	◉	◉
	L		○	◉		○	○		◉			◉	◉		○	○		○	○		◉	◉
	E		◉	◉		○	○		◉			◉	◉		○	○		○	○		◉	◉
Sheepshead minnow	A	◉	○	○	○	○	○	○	○		○	○	○	○	●	◉	○	●	◉	○	●	◉
	S		○	○		○	○	√	○		√	○	○	√	○	◉	√	●	◉		●	◉
Cyprinodon variegatus	J	◉	○	○	○	○	○	○	○		○	○	○	○	●	◉	○	●	◉	○	●	◉
	L		○	○		○	○	√	○		√	○	○	√	○	◉	√	●	◉		●	◉
	E		○	○		○	○	√	○		√	○	○	√	○	◉	√	●	◉		●	◉
Gulf killifish	A	○	○	○	○	○	○	○	○		◉	◉	◉	√	○	○	√	◉	○	√	◉	○
	S	○	○	○	○	◉	○	○	○		◉	◉	◉	√	○	○	√	◉	○	√	◉	○
Fundulus grandis	J	○	○	○	○	◉	○	○	○		◉	◉	◉	√	○	○	√	◉	○	√	◉	○
	L	○	○	○	○	◉	○	○	○		◉	◉	◉	√	○	○	√	◉	○	√	◉	○
	E	○	○	○	○	◉	○	○	○		◉	◉	◉	√	○	○	√	◉	○	√	◉	○
Silversides	A	●	●	◉	◉	◉	○	◉	●		◉	●	●	◉	●	◉	◉	◉	◉	◉	●	●
	S	◉	●	○	◉	◉	○	◉	●		◉	●	●	◉	●	●	◉	◉	◉	◉	●	●
Menidia species	J	●	●	○	◉	◉	○	◉	●		◉	●	●	◉	●	●	◉	◉	◉	◉	●	●
	L	◉	●	○	◉	◉	○	◉	●		◉	●	●	◉	●	●	◉	◉	◉	◉	●	●
	E	◉	●	○	◉	◉	○	◉	●		◉	●	●	◉	●	●	◉	◉	◉	◉	●	●

T M S T M S T M * T M S T M S T M S T M S
Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Apalachicola Bay			St. Andrew Bay			Choctawhatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
Species/Life Stage		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
Gizzard shad *Dorosoma cepedianum*	A	○	√					○	√		○	○		√	√		○	√		◉	○	√
	S	○						○			○			√			○			◉		
	J	○	√					○	√		○	○		√	√		○	√		○	○	√
	L	○						○			○			√			○			○		
	E	○						○			○			√			○			○		
Bay anchovy *Anchoa mitchilli*	A	○	●	◉	○	◉	◉	○	●	●	○	●	●	○	◉	◉	○	●	●	●	●	◉
	S		●	◉		◉	◉		●	●		●	●		○	○		●	●	◉	●	●
	J	○	●	◉	○	◉	◉	○	●	●	◉	●	●	◉	◉	◉	◉	●	●	○	◉	◉
	L		●	◉		◉	◉		●	●		●	●		○	○		●	●	√	○	○
	E		●	◉		◉	◉		●	●		○	○		○	○		●	●	○	●	○
Hardhead catfish *Arius felis*	A	○	●	●	○	●	●	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	●	●	○
	S		●	●		●	●		◉	◉		◉	◉		○	○		◉	◉	◉	◉	√
	J	○	●	●	○	●	●	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	◉	◉	○
	L		●	●		●	●		◉	◉		◉	◉		○	○		◉	◉	○	○	√
	E		●	●		●	●		◉	◉		◉	◉		○	○		◉	◉	○	○	√
Sheepshead minnow *Cyprinodon variegatus*	A	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	○	○	○	○	◉	◉	○	◉	○
	S	√	◉	◉	√	◉	◉	√	◉	◉	√	◉	◉	√	○	○	√	◉	◉	√	○	○
	J	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	○	○	○	○	◉	◉	√	○	○
	L	√	◉	◉	√	◉	◉	√	◉	◉	√	◉	◉	√	○	○	√	◉	◉	√	○	○
	E	√	◉	◉	√	◉	◉	√	◉	◉	√	◉	◉	√	○	○	√	◉	◉	√	○	○
Gulf killifish *Fundulus grandis*	A	○	○	○	○	○	○	○	○	○	○	○	○				○	◉	○	○	○	○
	S		○	○	√	○	○	√	○	○	√	○	○				√	◉	○		◉	○
	J	○	○	○	√	○	○	○	○	○	○	○	○				○	◉	○	√	○	○
	L		○	○	√	○	○	√	○	○	√	○	○				√	◉	○		○	√
	E		○	○	√	○	○	√	○	○	√	○	○				√	◉	○		○	√
Silversides *Menidia* species	A	◉	●	●	○	◉	◉	○	◉	◉	○	◉	◉	◉	◉	◉	○	◉	◉	◉	●	◉
	S	◉	●	●	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	●	●	●
	J	◉	●	●	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	◉	○	○
	L	◉	●	●	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	○	○	○
	E	◉	●	●	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	○	◉	◉	○	○	○

T M S T M S T M S T M S T M S T M S T M S
Apalachicola Bay | St. Andrew Bay | Choctawhatchee Bay | Pensacola Bay | Perdido Bay | Mobile Bay | Mississippi Sound
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Lake Borgn			Lake Pontchar-train			Breton/ Chandeleur Sounds			Mississippi River			Barataria Bay			Terrebonne/ Timbalier Bays			Atchafalaya/ Vermilion Bays		
Species/Life Stage		T	M	*	*	M	*	*	M	S	T	M	*	T	M	S	T	M	S	T	M	*
Gizzard shad *Dorosoma cepedianum*	A	●	○			○			○	○	○	○		○	○	○	○	○	○	○	○	
	S	○																				
	J	●	●			○					○	◉		○	○		○	○		○	○	
	L	○									○											
	E	○																				
Bay anchovy *Anchoa mitchilli*	A	●	●			●			◉	○	○	●		○	●	●	○	●	●	●	●	
	S		●			●			◉	○		◉			●	●		●	●		●	
	J	●	●			●			◉	○	○	●		○	●	●	○	●	●	●	●	
	L	●	●			●			◉	○		◉			●	●		●	●	○	●	
	E		●			●			◉	○		◉			●	●		●	●		●	
Hardhead catfish *Arius felis*	A	○	●			◉			○	○		●			●	●	○	◉	◉	○	◉	
	S		○			○			○	○		◉			◉	○		◉	○		○	
	J	○	◉			◉			◉	○		◉			●	●	○	◉	◉	○	○	
	L		○			○			○	○		◉			◉	○		◉	○		○	
	E		○			○			○	○		◉			◉	○		◉	○		○	
Sheepshead minnow *Cyprinodon variegatus*	A	○	○			○			○	○	○	◉		○	◉	●	○	○	○	○	○	
	S	○	○			○			○	○	○	◉			◉	◉	○	○	○	○	○	
	J	○	○			○			○	○	○	◉		○	◉	◉	○	○	○	○	◉	
	L	○	○			○			○	○	○	◉			◉	◉	○	○	○	○	○	
	E	○	○			○			○	○	○	◉			◉	◉	○	○	○	○	○	
Gulf killifish *Fundulus grandis*	A	○	◉			○			○		√	◉		○	●	◉	○	●	○	○	◉	
	S		○			○			○			◉			●			●			◉	
	J	○	○			○			○		√	◉		○	●	○	○	●	○	○	◉	
	L		○			○			○			◉			●			●		√	◉	
	E		○			○			○			◉			●			●			◉	
Silversides *Menidia* species	A	◉	◉			◉			○	○	√	◉			◉	◉	○	◉	◉	◉	◉	
	S	◉	◉			◉			○	○		◉			◉	◉		◉	◉	○	○	
	J	◉	◉			◉			○	○	√	◉			●	●	○	◉	◉	◉	◉	
	L	◉	◉			◉			○	○		◉			◉	◉		◉	◉	○	○	
	E	◉	◉			◉			○	○		◉			◉	◉		◉	◉	○	○	

T M * | * M * | * M S | T M * | T M S | T M S | T M *
Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays
Gulf of Mexico Estuaries

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity zone not present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Calcasieu Lake			Sabine Lake			Galveston Bay			Brazos River			Matagorda Bay			San Antonio Bay			Aransas Bay		
Species/Life Stage		T	M	*	T	M	*	T	M	S	T	M	*	T	M	S	*	M	S	*	M	S
Gizzard shad	A	○	○		○	○		○	○	○	○	○		◉	○	√		○	√		√	√
	S																					
Dorosoma cepedianum	J	○	○								na	na		◉	○	√		○			√	
	L																					
	E																					
Bay anchovy	A	○	●		◉	◉		◉	●	◉	na	●		◉	●	○		●	○		●	○
	S		●			○			●	◉		●		○	●	○		●	○		●	○
Anchoa mitchilli	J	○	●		◉	◉		◉	●	◉	na	●		◉	◉	○		◉	○		●	○
	L	○	●		○	○		○	●	◉		●		◉	○	○		●	○		●	○
	E		●			○			●	◉		●		○	○	○		●	○		●	○
Hardhead catfish	A	○	◉		√	○		○	◉	◉	○	○			◉	◉		◉	●		◉	○
	S		○			○			◉	◉		na			◉	◉		◉	●		◉	○
Arius felis	J	○	◉		√	○		√	◉	◉	○	na			◉	◉		◉	●		◉	○
	L		○			○			◉	◉		na			◉	◉		◉	●		◉	○
	E		○			○			◉	◉		na			◉	◉		◉	●		◉	○
Sheepshead minnow	A	○	○		◉	◉		○	◉	◉	◉	○		◉	◉	◉		◉	◉		◉	◉
	S	○	○		◉	◉		○	◉	◉	◉	○		◉	◉	◉		◉	◉		◉	◉
Cyprinodon variegatus	J	○	◉		◉	◉		○	◉	◉	◉	○		◉	◉	◉		◉	◉		◉	◉
	L	○	○		◉	◉		○	◉	◉	◉	○		◉	◉	◉		◉	◉		◉	◉
	E	○	○		◉	◉		○	◉	◉	◉	○		◉	◉	◉		◉	◉		◉	◉
Gulf killifish	A	○	○		○	◉		○	◉	◉	◉	◉		◉	◉	◉		◉	◉		◉	○
	S		○			◉			◉	◉		○			◉	◉		◉	◉		◉	○
Fundulus grandis	J	○	◉		○	◉		○	◉	◉	◉	◉		◉	◉	◉		◉	◉		◉	○
	L	√	○		√	◉		√	◉	◉	√	○			◉	◉		◉	◉		◉	○
	E		○			◉			◉	◉		○			◉	◉		◉	◉		◉	○
Silversides	A	○	◉		○	◉		◉	◉	○	◉	◉		◉	◉	√		◉	√		◉	○
	S	○	◉		○	◉		◉	◉		◉	◉		◉	◉			◉			◉	√
Menidia species	J	○	◉		○	◉		◉	◉	○	◉	◉		◉	◉	√		◉	√		◉	○
	L	○	◉		○	◉		◉	◉		◉	◉		◉	◉			◉			◉	√
	E	○	◉		○	◉		◉	◉		◉	◉		◉	◉			◉			◉	√

T M * T M * T M S T M * T M S * M S * M S
Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Relative Abundance
- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present
- na No Data Available

Salinity Zone
- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage
- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries								
		Corpus Christi Bay			Laguna Madre			Baffin Bay		
Species/Life Stage		*	M	S	*	*	S	*	*	S
Gizzard shad	A		○	√			√			◉
	S									
Dorosoma cepedianum	J		○							◉
	L									
	E									
Bay anchovy	A		●	○			●			●
	S		●	○			●			●
Anchoa mitchilli	J		●	○			●			●
	L		●	○			●			●
	E		●	○			●			●
Hardhead catfish	A		◉	○			◉			●
	S		◉	○			◉			●
Arius felis	J		◉	○			●			●
	L		◉	○			◉			●
	E		◉	○			◉			●
Sheepshead minnow	A		◉	◉			●			◉
	S		◉	◉			●			◉
Cyprinodon variegatus	J		◉	◉			●			●
	L		◉	◉			●			◉
	E		◉	◉			●			◉
Gulf killifish	A		○	○			◉			◉
	S		○	○			◉			◉
Fundulus grandis	J		○	○			◉			◉
	L		○	○			◉			◉
	E		○	○			◉			◉
Silversides	A		◉	○			●			●
	S		◉	○			●			●
Menidia species	J		◉	○			●			●
	L		◉	○			●			●
	E		◉	○			●			●
		*	M	S	*	*	S	*	*	S
		Corpus Christi Bay			Laguna Madre			Baffin Bay		
		Gulf of Mexico Estuaries								

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity zone not present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 4, continued. Spatial distribution and relative abundance

Species/Life Stage		Florida Bay			Ten Thousand Islands			Caloosa-hatchee River			Charlotte Harbor			Tampa Bay			Suwannee River			Apalachee Bay		
		T	M	S	T	M	S	T	M	*	T	M	S	T	M	S	T	M	S	T	M	S
Snook	A	√	○	○	○	◉	◉	○	○		○	◉	◉	○	○	○	○	○	○	○	○	○
	S						◉					√	○		√	◉						
Centropomus undecimalis	J	○	○	○	◉	◉	○	◉	◉		◉	◉	◉	○	○	○						
	L				○	○	◉	○	○		○	√	○		◉	◉						
	E						◉					√	○		◉	◉						
Bluefish	A		○	○		○	○					√	○			○		○	○		○	○
	S																					
Pomatomus saltatrix	J		√	√		√	√					○	○			√		○	○		○	○
	L																					
	E																					
Blue runner	A			√			○					√	○			○			○			○
	S																					
Caranx crysos	J			√			○					√	○			○			○			○
	L																					
	E																					
Crevalle jack	A		◉	◉		○	○	√	○			◉	◉		√	◉	√	○	○		○	○
	S																					
Caranx hippos	J	√	◉	◉	√	○	○	√	○			○	○		○	◉	√	○	○		○	○
	L																					
	E																					
Florida pompano	A			●			○						◉			○			√			○
	S																					
Trachinotus carolinus	J			◉			○						◉		○	○			√			○
	L																					
	E																					
Gray snapper	A												○				√	○	○	√	○	○
	S																					
Lutjanus griseus	J	√	◉	◉	○	○	○		√		√	√	○		√	○	√	○	○	√	○	○
	L																					
	E																					

Gulf of Mexico Estuaries

T M S T M S T M * T M S T M S T M S T M S
Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Apalachicola Bay			St. Andrew Bay			Choctawhatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
Species/Life Stage		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
Snook	A	○	○	○																		
	S																					
Centropomus undecimalis	J																					
	L																					
	E																					
Bluefish	A		○	○		◉	◉		◉	◉		○	○		○	○		○	○			○
	S																					
Pomatomus saltatrix	J		○	○		○	○		○	○		○	○		○	○		○	○			○
	L																					
	E																					
Blue runner	A			○			◉			○			○			○			○		○	○
	S																					◉
Caranx crysos	J			○			○			○			○			○			○		○	◉
	L																				○	◉
	E																					◉
Crevalle jack	A		○	○		○	○		○	○		○	○			○			○		√	○
	S																					○
Caranx hippos	J		○	○		○	○		○	○		○	○	√	○	○		○	○	√	○	○
	L																					○
	E																					○
Florida pompano	A						○			○		√	√					√	○			√
	S																		√			○
Trachinotus carolinus	J						○					√	○		○	○		√	○		√	◉
	L																		√			○
	E																		√			○
Gray snapper	A		√	√		√	○	√	○	○		◉	○				√	√	√			
	S																					
Lutjanus griseus	J		√	√	√	○	○	○	○	○		○	○	√	○	○	√	○	○			
	L																					
	E																					
		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
		Apalachicola Bay			St. Andrew Bay			Choctawhatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
		Gulf of Mexico Estuaries																				

Relative Abundance
- ⬤ Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone
- T - Tidal Fresh
- M - Mixing
- S - Seawater

Life Stage
- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Lake Borgn			Lake Pontchar-train			Breton/ Chandeleur Sounds			Mississippi River			Barataria Bay			Terrebonne/ Timbalier Bays			Atchafalaya/ Vermilion Bays		
Species/Life Stage		T	M	*	*	M	*	*	M	S	T	M	*	T	M	S	T	M	S	T	M	*
Snook	A															√						
	S																					
Centropomus undecimalis	J																					
	L																					
	E																					
Bluefish	A											√										
	S																					
Pomatomus saltatrix	J								√	√		√			√	○		√	√		√	
	L																					
	E																					
Blue runner	A																					
	S																					
Caranx crysos	J															○			√			
	L																					
	E																					
Crevalle jack	A								○	○					○	○			√			
	S																					
Caranx hippos	J	○	○			○			○	○		○			○	○		○	○	○	○	
	L																					
	E																					
Florida pompano	A									○									√			
	S									○												
Trachinotus carolinus	J									○		○			○	○		√	○		√	
	L									○												
	E									○												
Gray snapper	A																					
	S																					
Lutjanus griseus	J								○	○					○	○		√	√			
	L																					
	E																					

T M * * M * * M S T M * T M S T M S T M *
Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Calcasieu Lake			Sabine Lake			Galveston Bay			Brazos River			Matagorda Bay			San Antonio Bay			Aransas Bay		
Species/Life Stage		T	M	*	T	M	*	T	M	S	T	M	*	T	M	S	*	M	S	*	M	S
Snook	A									√				√	√	√					√	√
	S																					√
Centropomus undecimalis	J									√				√	√	√					√	√
	L																					√
	E																					√
Bluefish	A																		√		√	√
	S																					
Pomatomus saltatrix	J		√			√		√	√	○	na	○			√	√					√	√
	L																					
	E																					
Blue runner	A									√												
	S																					
Caranx crysos	J									√												
	L																					
	E																					
Crevalle jack	A				√	√		√	√	√					○	○		○	○		○	○
	S																					
Caranx hippos	J		○			√			○	○		○			○	○		○	○		○	○
	L																					
	E																					
Florida pompano	A																		○		√	√
	S																					
Trachinotus carolinus	J		○							○						○			○		√	○
	L																					
	E																					
Gray snapper	A															√					√	√
	S																					
Lutjanus griseus	J		√							√						√			√		√	√
	L																					
	E																					

T M * T M * T M S T M * T M S * M S * M S
Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present
- n No Data Available

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay *	Corpus Christi Bay M	Corpus Christi Bay S	Laguna Madre *	Laguna Madre *	Laguna Madre S	Baffin Bay *	Baffin Bay *	Baffin Bay S
Snook	A		√	√			√			
	S			√			√			
Centropomus undecimalis	J		√	√			○			
	L			√			√			
	E			√			√			
Bluefish	A		√	√						
	S									
Pomatomus saltatrix	J		√	√						
	L									
	E									
Blue runner	A									
	S									
Caranx crysos	J									
	L									
	E									
Crevalle jack	A		○	○			○			○
	S									
Caranx hippos	J		○	○			◉			○
	L									
	E									
Florida pompano	A		√	√			○			√
	S									
Trachinotus carolinus	J		√	○			◉			√
	L									
	E									
Gray snapper	A		√	√			√			√
	S									
Lutjanus griseus	J		√	√			○			√
	L									
	E									

* M S * * S * * S
Corpus Christi Bay | Laguna Madre | Baffin Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Florida Bay			Ten Thousand Islands			Caloosa-hatchee River			Charlotte Harbor			Tampa Bay			Suwannee River			Apalachee Bay		
Species/Life Stage		T	M	S	T	M	S	T	M	*	T	M	S	T	M	S	T	M	S	T	M	S
Sheepshead	A	√	○	○	√	○	○		√			√	√		○	○		○	○		√	√
	S															√						
Archosargus probatocephalus	J	√	○	○	○	○	○	√	√		√	√	√	○	○	○	○	○	○	√	√	√
	L		√	○		√	○		√			√	√		○	○		○	○		√	√
	E															√						
Pinfish	A	√	●	●		●	●	√	○		√	◉	●		●	●	√	●	●		◉	◉
	S																					
Lagodon rhomboides	J	√	◉	●	○	◉	○	○	●		√	●	●		●	●	√	●	●	○	◉	◉
	L			√		◉	◉					○	●			○		√	○			○
	E																					
Silver perch	A	√	○	○	√	○	○	√	◉		√	◉	◉	√	◉	◉	√	◉	◉	√	○	○
	S			○		◉	◉		◉			●	●		●	◉		◉	◉		○	○
Bairdiella chrysoura	J	√	○	◉	√	○	◉	√	◉		√	◉	◉	√	◉	◉	√	○	○	√	○	○
	L		√	○		◉	◉		◉			●	●		◉	◉		◉	◉		○	○
	E			○		◉	◉		◉			●	●		◉	◉		◉	◉		○	○
Sand seatrout	A					○	○	√	√		○	◉	●	√	◉	◉	√	○	◉	√	○	◉
	S								√			√	◉		◉	◉			○			○
Cynoscion arenarius	J			√		◉	○	◉	●		○	◉	●	√	◉	◉	√	●	●	√	●	●
	L						◉		√			√	◉		◉	◉		√	○		√	○
	E								√			√	◉		◉	◉			○			○
Spotted seatrout	A		◉	◉		○	○		○			◉	◉		○	○	√	◉	◉	√	○	○
	S		◉	◉		○	○		○			◉	◉		○	○		◉	◉		√	○
Cynoscion nebulosus	J		◉	◉		○	○	√	○			◉	◉		○	○	√	◉	◉	√	○	○
	L		◉	◉		○	○	√	○			◉	◉		○	○		◉	◉		○	○
	E		◉	◉		○	○		○			◉	◉		○	○		◉	◉		√	○
Spot	A							√	√			√	√		◉	◉	√	○	○	√	◉	◉
	S																					
Leiostomus xanthurus	J			○		○	○	○	○		○	○	○	◉	●	●	○	◉	○	○	●	●
	L						◉						√		○	●			○			○
	E																					

T M S T M S T M * T M S T M S T M S T M S
Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Apalachicola Bay			St. Andrew Bay			Choctawhatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
Species/Life Stage		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
Sheepshead	A		○	○		○	○		○	○		○	○	√	○	◉		○	◉	○	○	○
	S						○															○
Archosargus probatocephalus	J	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	○	√	○	○
	L		○	○		○	○		○	○		○	○		○	○		○	○		○	○
	E						√														√	○
Pinfish	A		◉	◉	√	●	●		○	○	◉	◉	◉	√	○	○	√	◉	◉	√	●	○
	S																					○
Lagodon rhomboides	J	○	◉	◉	√	●	●	○	◉	◉	√	●	●	√	◉	◉	√	◉	◉	√	●	○
	L			○		◉	◉		●	●		○	◉		√	○			◉		◉	○
	E																					○
Silver perch	A	√	◉	◉	√	◉	◉	√	○	○	√	○	○	√	○	○	√	○	○	√	●	√
	S		◉	◉		◉	◉		○	○		○	○		○	○		○	○		○	√
Bairdiella chrysoura	J	√	◉	◉	√	◉	◉	√	○	○	√	○	○	√	○	○	√	○	○	○	●	√
	L		◉	◉		◉	◉		○	○		○	○		○	○		○	○		○	√
	E		◉	◉		◉	◉		○	○		○	○		○	○		○	○		○	√
Sand seatrout	A		◉	◉	√	○	○	○	◉	◉	√	○	○	√	○	○	○	●	◉	◉	●	●
	S					○	○		◉	●		○	○		○	○		◉	●			○
Cynoscion arenarius	J		●	●	○	◉	◉	○	◉	◉	○	○	○	√	○	○	○	◉	◉	○	●	○
	L			◉		○	○		◉	●		○	○		○	○	√	◉	●	○	●	○
	E					○	○		◉	●		○	○		○	○		◉	●			○
Spotted seatrout	A	√	○	○	√	◉	◉	√	◉	◉	√	○	○	√	○	○	√	◉	◉		◉	◉
	S		○	○		√	○			√		√	○			√			√		◉	◉
Cynoscion nebulosus	J		○	○	√	○	○	√	◉	◉	√	○	○	√	○	○	√	◉	○		◉	◉
	L		○	○		○	○		○	◉		○	○		○	○	√	○	◉		◉	◉
	E		○	○		√	○			√		√	○			√			√		◉	◉
Spot	A		○	◉	√	◉	◉	√	◉	◉	√	√	√	√	○	○	√	○	○	○	●	●
	S																					◉
Leiostomus xanthurus	J	○	◉	◉	○	◉	◉	√	●	●	√	●	●	√	◉	◉	√	●	●	◉	●	○
	L			○		○	○		◉	●		○	●		○	◉		○	○		●	●
	E																					●

T M S T M S T M S T M S T M S T M S T M S
Apalachicola Bay | St. Andrew Bay | Choctawhatchee Bay | Pensacola Bay | Perdido Bay | Mobile Bay | Mississippi Sound
Gulf of Mexico Estuaries

Relative Abundance
- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone
- T - Tidal Fresh
- M - Mixing
- S - Seawater

Life Stage
- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Lake Borgn			Lake Pontchartrain			Breton/ Chandeleur Sounds			Mississippi River			Barataria Bay			Terrebonne/ Timbalier Bays			Atchafalaya/ Vermilion Bays		
Species/Life Stage		T	M	*	*	M	*	*	M	S	T	M	*	T	M	S	T	M	S	T	M	*
Sheepshead	A	○	○			○			○	○	√	○		○	◉	◉	○	◉	◉	○	○	
	S																					
Archosargus probatocephalus	J		◉			○			○	○	○	○		○	○	○	○	◉	◉	○	○	
	L																					
	E																					
Pinfish	A	○	◉			○															√	
	S																					
Lagodon rhomboides	J	○	◉			◉			○	○		○		√	○	◉		◉	◉		○	
	L																					
	E																					
Silver perch	A	√	●			○			○	○		○			○	◉		○	○			
	S		○													◉			○			
Bairdiella chrysoura	J	√	●			○			○	○		○			○	◉		◉	◉	○	○	
	L		○													◉			○			
	E		○													◉			○			
Sand seatrout	A	●	●			○			○	○					○	○		○	○	√	○	
	S		○																			
Cynoscion arenarius	J	○	◉			◉			○	○		●			◉	◉		◉	◉	◉	◉	
	L		○																			
	E		○																			
Spotted seatrout	A	○	◉			○			◉	◉		◉		√	○	○	√	○	◉		◉	
	S		◉			○			○						○	○		○	○		○	
Cynoscion nebulosus	J	○	◉			○			○	○		◉		√	○	○	√	◉	○		○	
	L		◉			○			○						○	○		○	○		○	
	E		◉			○			○						○	○		○	○		○	
Spot	A	√	○			○			○	○		◉						○	○			
	S																					
Leiostomus xanthurus	J	○	●			○			◉	◉		◉		○	◉	●	○	◉	◉	◉	◉	
	L	√	●			○									◉	◉						
	E																					

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity zone not present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Calcasieu Lake			Sabine Lake			Galveston Bay			Brazos River			Matagorda Bay			San Antonio Bay			Aransas Bay		
Species/Life Stage		T	M	*	T	M	*	T	M	S	T	M	*	T	M	S	*	M	S	*	M	S
Sheepshead	A	√	√		○	○			○	○	na	○		○	◉	◉		◉	○		○	○
	S																				○	○
Archosargus probatocephalus	J	√	○		○	○		○	○	○	na	○		○	◉	○		○	○		○	○
	L																				○	○
	E																				○	○
Pinfish	A		○											○	○	◉		√	○		◉	◉
	S																					
Lagodon rhomboides	J	√	○		○	○		○	◉	◉	na	◉		○	◉	●		◉	◉		◉	◉
	L																					
	E																					
Silver perch	A				○	○		√	○	○	na	○		○	○	○		○	√		○	○
	S								○	○		○			○	○		○	√		○	○
Bairdiella chrysoura	J		○		√	√		√	○	○	na	○			○	○		○	√		○	○
	L								○	○		○			○	○		○	√		○	○
	E								○	○		○			○	○		○	√		○	○
Sand seatrout	A		○						◉	◉					○	○					○	○
	S																					○
Cynoscion arenarius	J		◉			√		√	○	○	na	○		○	○	○		○	○		○	○
	L																					○
	E																					○
Spotted seatrout	A	√	○		√	√		√	○	○	na	○		√	○	○		○	○		○	○
	S		○			√			○	○		○			○	○		○	○		○	○
Cynoscion nebulosus	J	√	○		○	○		√	○	○	na	○		√	○	○		○	○		○	○
	L		○		○	√			○	○		○			○	○		○	○		○	○
	E		○			√			○	○		○			○	○		○	○		○	○
Spot	A				◉	◉		√	○	○	na	na		○	○	○		○	○		◉	◉
	S																					
Leiostomus xanthurus	J	√	○		○	○		○	◉	○	○	◉		○	◉	○		◉	○		◉	◉
	L																					
	E																					
		T	M	*	T	M	*	T	M	S	T	M	*	T	M	S	*	M	S	*	M	S
		Calcasieu Lake			Sabine Lake			Galveston Bay			Brazos River			Matagorda Bay			San Antonio Bay			Aransas Bay		
		Gulf of Mexico Estuaries																				

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present
- n No Data Available

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries								
		Corpus Christi Bay			Laguna Madre			Baffin Bay		
Species/Life Stage		*	M	S	*	*	S	*	*	S
Sheepshead	A		○	○			○			○
	S		○	○						√
Archosargus probatocephalus	J		○	○			◉			○
	L		○	○						√
	E		○	○						√
Pinfish	A		◉	◉			◉			○
	S									
Lagodon rhomboides	J		◉	◉			●			◉
	L									
	E									
Silver perch	A		○	○			○			◉
	S		○	○			○			◉
Bairdiella chrysoura	J		○	○			◉			◉
	L		○	○			○			◉
	E		○	○			○			◉
Sand seatrout	A		◉	◉			√			○
	S			○						
Cynoscion arenarius	J		◉	○			√			○
	L			○						
	E			○						
Spotted seatrout	A		○	○			○			○
	S		○	○			○			○
Cynoscion nebulosus	J		○	○			○			○
	L		○	○			○			○
	E		○	○			○			○
Spot	A		◉	◉			◉			○
	S									
Leiostomus xanthurus	J		◉	◉			●			●
	L									
	E									
		*	M	S	*	*	S	*	*	S
		Corpus Christi Bay			Laguna Madre			Baffin Bay		
		Gulf of Mexico Estuaries								

Relative Abundance		Salinity Zone	Life Stage
●	Highly Abundant	T - Tidal Fresh	A - Adults
◉	Abundant	M - Mixing	S - Spawning adults
○	Common	S - Seawater	J - Juveniles
√	Rare	* - Salinity zone not present	L - Larvae
Blank	Not Present		E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Florida Bay			Ten Thousand Islands			Caloosa-hatchee River			Charlotte Harbor			Tampa Bay			Suwannee River			Apalachee Bay		
Species/Life Stage		T	M	S	T	M	S	T	M	*	T	M	S	T	M	S	T	M	S	T	M	S
Atlantic croaker	A																○	○	○		○	○
	S																					
Micropogonias undulatus	J			√			√	√	√		○	○	√		√	√	○	○	○	○	○	○
	L																		○			○
	E																					
Black drum	A		○	○		○	○		○			○	○		○	○		○	○		○	○
	S			√		√	√								○	○						
Pogonias cromis	J	√	√	√	√	√	√	√	○		√	○	○	√	○	○	√	○	○	√	○	○
	L		√	○		○	○		○			○	○		○	○		○	○		○	○
	E			√			√								√	√						
Red drum	A		√	√		√	√	√	√			√	○	√	○	○		○	○	√	○	○
	S												√			√			√			√
Sciaenops ocellatus	J	√	○	○	√	√	√	○	◉		○	◉	◉	○	●	●		○	○	√	○	○
	L			√		√	√		○			○	○		○	◉		√	○		√	○
	E											√	√			√			√			√
Striped mullet	A	○	◉	◉	○	◉	◉	○	○		○	◉	◉	○	○	○	○	◉	◉	●	●	●
	S																					
Mugil cephalus	J	○	●	◉	○	●	◉	●	●		●	●	●	●	●	●	○	◉	◉	●	●	●
	L			○									√						○			◉
	E																					
Code goby	A	√	●	◉	√	●	●	√	◉		√	◉	●	√	◉	◉	√	○	○		○	○
	S		●	◉		●	◉		◉			◉	●		○	◉		○	○		○	○
Gobiosoma robustum	J	√	●	●	√	●	◉	√	◉		√	◉	●	√	◉	◉	√	○	○		○	○
	L		●	◉		●	◉		◉			◉	●		◉	◉		○	○		○	○
	E		●	◉		●	◉		◉			◉	●		◉	◉		○	○		○	○
Spanish mackerel	A		○	○		○	○		√			√	○			○		√	√		√	√
	S																					
Scomberomorus maculatus	J		○	○	√	○	○		√			○	○		√	√		√	○		√	√
	L																					
	E																					

T M S T M * T M S T M S T M S T M S
Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Apalachicola Bay			St. Andrew Bay			Choctawhatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
Species/Life Stage		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
Atlantic croaker	A		◉	◉		◉	◉		◉	◉		◉	◉		○	○		◉	◉	○	●	◉
	S																				◉	◉
Micropogonias undulatus	J	◉	●	●	√	◉	◉	○	◉	◉	◉	●	●	○	○	○	◉	●	●	◉	●	○
	L		◉	◉		○	○		◉	◉		○	●		√	○		√	◉	○	●	○
	E																				◉	○
Black drum	A		○	○		○	○		○	○		○	○		√	○	√	○	○		○	○
	S					○	○														○	○
Pogonias cromis	J	√	○		√	○	○	√	○	○	√	○	○	√	○	○	√	○	○		○	○
	L		○	○		○	○		○	○		○	○		○	○		○	○		○	○
	E					√	√														○	○
Red drum	A	√	○	○		○	◉	√	○	○		○	○			√	√	○	√		○	○
	S			√						√						√						○
Sciaenops ocellatus	J	√	○	○	√	○	○	√	○	○	√	○	○		○	○	√	○	○	√	○	
	L		√	○		√	○		○	○		√	○			√			○		◉	○
	E			√			√			√			√			√			√			○
Striped mullet	A	◉	◉	◉	○	◉	●	○	◉	◉	◉	◉	◉	√	○	○	◉	◉	◉	○	●	●
	S																					●
Mugil cephalus	J	◉	◉	◉	○	●	●	○	◉	◉	◉	◉	◉	√	◉	◉	◉	◉	◉	○	◉	◉
	L			○		○	○		◉	◉		◉	◉		○	○		◉	◉		●	◉
	E																					◉
Code goby	A	√	○	○	√	◉	◉	√	○	○	√	○	○		√	√					○	○
	S		○	○		◉	◉		○	○		○	○		√	√					○	○
Gobiosoma robustum	J	√	○	○	√	◉	◉	√	○	○	√	○	○		√	√					○	○
	L		○	○		◉	◉		○	○		○	○		√	√					○	○
	E		○	○		◉	◉		○	○		○	○		√	√					○	○
Spanish mackerel	A		√	√		√	◉		○	○		○	○		○	◉		○	○			◉
	S																					√
Scomberomorus maculatus	J		√	√		√	◉		○	○		○	○			○		○	○	√	○	○
	L																					√
	E																					√

T M S T M S T M S T M S T M S T M S T M S
Apalachicola Bay | St. Andrew Bay | Choctawhatchee Bay | Pensacola Bay | Perdido Bay | Mobile Bay | Mississippi Sound
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Lake Borgn			Lake Pontchar-train			Breton/ Chandeleur Sounds			Mississippi River			Barataria Bay			Terrebonne/ Timbalier Bays			Atchafalaya/ Vermilion Bays		
Species/Life Stage		T	M	*	*	M	*	*	M	S	T	M	*	T	M	S	T	M	S	T	M	*
Atlantic croaker *Micropogonias undulatus*	A	○	○			○			○	○												
	S																					
	J	◉	●			●			◉	◉		●		○	●	●	○	●	◉	●	●	
	L	√	◉												○	◉			◉		○	
	E																					
Black drum *Pogonias cromis*	A	√	○			○			○	◉	√	○		√	○	◉		○	◉		○	
	S																		○			
	J	√	○			○			○	◉	√	○		√	○	○		○	○	√	○	
	L		√																○			
	E																		○			
Red drum *Sciaenops ocellatus*	A		○						◉	◉				√	√	○		√	√		√	
	S															√						
	J	○	◉			○			◉	◉	○	○		○	○	○	√	○	○	○	○	
	L														○	○						
	E															√						
Striped mullet *Mugil cephalus*	A	○	●			○			◉	◉	○	◉		√	○	○	○	○	○	◉	○	
	S																					
	J	○	◉			◉			○	○	○	◉		√	○	◉	○	◉	◉	◉	◉	
	L		√												○	○						
	E																					
Code goby *Gobiosoma robustum*	A		○			○										√						
	S		●			○																
	J		◉			○										√						
	L		●			○																
	E		●			○																
Spanish mackerel *Scomberomorus maculatus*	A									○						○		√	√			
	S																					
	J		√			√			○	○		√			○	○		○	○	○	○	
	L																					
	E																					

T M * * M * * M S T M * T M S T M S T M *
Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Calcasieu Lake			Sabine Lake			Galveston Bay			Brazos River			Matagorda Bay			San Antonio Bay			Aransas Bay		
Species/Life Stage		T	M	*	T	M	*	T	M	S	T	M	*	T	M	S	*	M	S	*	M	S
Atlantic croaker *Micropogonias undulatus*	A				◉	◉		√	○	○	na	na		◉	◉	◉		◉	◉		◉	○
	S																					
	J	○	●		○	◉		◉	●	●	○	●		◉	●	◉		●	◉		◉	◉
	L																					◉
	E																					
Black drum *Pogonias cromis*	A		○			√			○	○		○			○	○		○	○		○	○
	S									○						○						○
	J		○		○	○		√	○	○	○	○		○	○	○		○	○		○	○
	L									○						○						○
	E									○						○						○
Red drum *Sciaenops ocellatus*	A				√	√		√	○	○	na	na		√	√	○		√	√		√	√
	S															○						
	J		◉		○	○		○	○	○	na	○		○	○	○		○	○		○	○
	L								○	○						○						
	E															○						
Striped mullet *Mugil cephalus*	A				○	○		○	○	○	na	○		○	◉	◉		○	○		○	○
	S															◉						
	J	√	◉		○	○		○	◉	◉	na	○		◉	◉	◉		◉	○		◉	◉
	L															◉						
	E															◉						
Code goby *Gobiosoma robustum*	A									√		na			○	○		√	√		○	○
	S									√		na			○	○		√	√		○	○
	J									√		na			○	○		√	√		○	○
	L									√		na			○	○		√	√		○	○
	E									√		na			○	○		√	√		○	○
Spanish mackerel *Scomberomorus maculatus*	A					○													√			√
	S																					
	J		○			√			○	○		√			√	√			√		√	√
	L																					
	E																					

T M * T M * T M S T M * T M S * M S * M S
Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present
- n No Data Available

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay *	Corpus Christi Bay M	Corpus Christi Bay S	Laguna Madre *	Laguna Madre *	Laguna Madre S	Baffin Bay *	Baffin Bay *	Baffin Bay S
Atlantic croaker *Micropogonias undulatus*	A		◉	○			◉			◉
	S									
	J		◉	◉			◉			◉
	L		○	◉			◉			
	E									
Black drum *Pogonias cromis*	A		○	○			○			◉
	S			○			○			◉
	J		○	○			○			◉
	L			○			○			◉
	E			○			○			◉
Red drum *Sciaenops ocellatus*	A		√	√			√			√
	S									
	J		○	○			○			○
	L									
	E									
Striped mullet *Mugil cephalus*	A		○	○			○			◉
	S						○			
	J		◉	◉			◉			◉
	L						○			
	E						○			
Code goby *Gobiosoma robustum*	A		○	○			◉			◉
	S		○	○			◉			◉
	J		○	○			◉			◉
	L		○	○			◉			◉
	E		○	○			◉			◉
Spanish mackerel *Scomberomorus maculatus*	A		√	√						
	S									
	J		√	√			√			
	L									
	E									

* M S * * S * * S
Corpus Christi Bay | Laguna Madre | Baffin Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Florida Bay			Ten Thousand Islands			Caloosa-hatchee River			Charlotte Harbor			Tampa Bay			Suwannee River			Apalachee Bay		
Species/Life Stage		T	M	S	T	M	S	T	M	*	T	M	S	T	M	S	T	M	S	T	M	S
Gulf flounder	A		○	○		○	○		√			○	○		○	○		○	○		○	○
	S																					
Paralichthys albigutta	J		○	○		○	○		√			○	○		○	○		○	○		○	○
	L		○	○								√	○					√	○		√	○
	E																					
Southern flounder	A			√			√				√	√	√	√	√	√	○	○	○	○	○	○
	S																					
Paralichthys lethostigma	J			√			√				√	√	√	√	√		○	○	√	○	○	√
	L											√	√			√			○		○	○
	E																					

T M S T M S T M * T M S T M S T M S T M S
Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Relative Abundance

- ● Highly Abundant
- ◉ Abundant
- ○ Common
- √ Rare
- Blank Not Present

Salinity Zone

- T - Tidal Fresh
- M - Mixing
- S - Seawater
- * - Salinity zone not present

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Apalachicola Bay			St. Andrew Bay			Choctawhatchee Bay			Pensacola Bay			Perdido Bay			Mobile Bay			Mississippi Sound		
Species/Life Stage		T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
Gulf flounder	A		√	○		○	◉		○	○		○	○		√	○		√	√		√	○
	S																					○
Paralichthys albigutta	J		√	○		○	◉		○	○		○	○		○	○		√	○		√	○
	L		√	○			○			○			○			○			○		√	○
	E																					○
Southern flounder	A	○	○	○	○	○	○	√	○	○	○	○	○	√	○	○	○	○	○	√	◉	◉
	S																					◉
Paralichthys lethostigma	J	○	○	√	○	○	○	○	○	○	○	○	√	○	○	○	○	○	○	√	◉	○
	L		○	○		○	○		○	○		○	○		○	○		○	○		◉	◉
	E																					○

T M S T M S T M S T M S T M S T M S T M S
Apalachicola Bay | St. Andrew Bay | Choctawhatchee Bay | Pensacola Bay | Perdido Bay | Mobile Bay | Mississippi Sound
Gulf of Mexico Estuaries

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Lake Borgn			Lake Pontchar-train			Breton/ Chandeleur Sounds			Mississippi River			Barataria Bay			Terrebonne/ Timbalier Bays			Atchafalaya/ Vermilion Bays		
Species/Life Stage		T	M	*	*	M	*	*	M	S	T	M	*	T	M	S	T	M	S	T	M	*
Gulf flounder *Paralichthys albigutta*	A																					
	S																					
	J																					
	L																					
	E																					
Southern flounder *Paralichthys lethostigma*	A	√	○			○			◉	◉		◉			○	◉		○	◉	○	○	
	S																					
	J	√	○			○			○	○		◉			○	◉		○	○	○	○	
	L															○						
	E																					

T M * * M * * M S T M * T M S T M S T M *
Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays
Gulf of Mexico Estuaries

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity zone not present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 4, continued. Spatial distribution and relative abundance

		Gulf of Mexico Estuaries																				
		Calcasieu Lake			Sabine Lake			Galveston Bay			Brazos River			Matagorda Bay			San Antonio Bay			Aransas Bay		
Species/Life Stage		T	M	*	T	M	*	T	M	S	T	M	*	T	M	S	*	M	S	*	M	S
Gulf flounder	A									√					√	√			√		√	√
	S																					
Paralichthys albigutta	J									√					√	√		√	√		√	√
	L																					
	E																					
Southern flounder	A		○		●	●		○	◉	●	na	○		○	◉	○		○	◉		○	○
	S																					
Paralichthys lethostigma	J		◉		○	○		○	○	○	na	○		○	○	○		○	○		○	○
	L																					
	E																					

T M * T M * T M S T M * T M S * M S * M S
Calcasieu Lake, Sabine Lake, Galveston Bay, Brazos River, Matagorda Bay, San Antonio Bay, Aransas Bay
Gulf of Mexico Estuaries

Relative Abundance

● Highly Abundant
◉ Abundant
○ Common
√ Rare
Blank Not Present
n No Data Available

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity zone not present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 4, continued. Spatial distribution and relative abundance

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay *	Corpus Christi Bay M	Corpus Christi Bay S	Laguna Madre *	Laguna Madre *	Laguna Madre S	Baffin Bay *	Baffin Bay *	Baffin Bay S
Gulf flounder	A		√	√			√			
	S									
Paralichthys albigutta	J		√	√			√			√
	L									
	E									
Southern flounder	A		○	○			○			○
	S									
Paralichthys lethostigma	J		○	○			◉			○
	L									
	E									

* M S * * S * * S
Corpus Christi Bay Laguna Madre Baffin Bay
Gulf of Mexico Estuaries

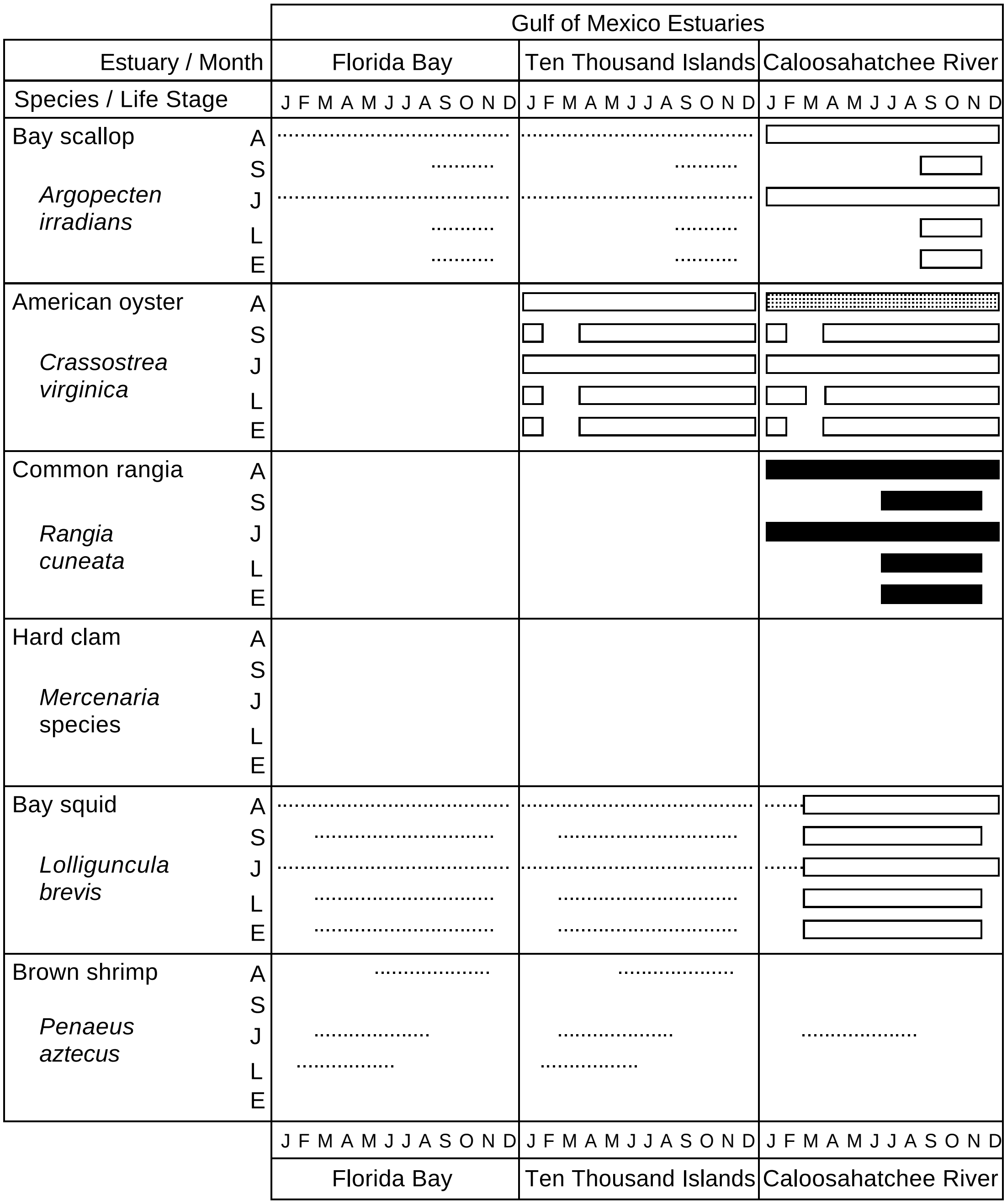
Relative Abundance		Salinity Zone	Life Stage
●	Highly Abundant	T - Tidal Fresh	A - Adults
◉	Abundant	M - Mixing	S - Spawning adults
○	Common	S - Seawater	J - Juveniles
√	Rare	* - Salinity zone not present	L - Larvae
Blank	Not Present		E - Eggs

Table 5. Temporal distribution

Index to Table 5. Page location of temporal distribution table for each species and estuary.

	Estuary										
Common and Scientific Name	Florida Bay Ten Thousand Islands Caloosahatchee River	Charlotte Harbor Tampa Bay Suwannee River	Apalachee Bay Apalachicola Bay St. Andrew Bay	Choctawhatchee Bay Pensacola Bay Perdido Bay	Mobile Bay Mississippi Sound Lake Borgne	Breton/Chandeleur Sound Lake Pontchartrain Mississippi River	Barataria Bay Terrebonne/Timbalier Bay Atchafalaya/Vermilion Bay	Calcasieu Lake Sabine Lake Galveston Bay	Brazos River Matagorda Bay San Antonio Bay	Aransas Bay Corpus Christi Bay Laguna Madre	Baffin Bay
Bay scallop (*Argopecten irradians*) American oyster (*Crassostrea virginica*) Common rangia (*Rangia cuneata*) Hard clam (*Mercenaria* species) Bay squid (*Lolliguncula brevis*) Brown shrimp (*Penaeus aztecus*)	62	63	64	65	66	67	68	69	70	71	72
Pink shrimp (*Penaeus duorarum*) White shrimp (*Penaeus setiferus*) Grass shrimp (*Palaemonetes pugio*) Spiny lobster (*Panulirus argus*) Blue crab (*Callinectes sapidus*) Gulf stone crab (*Menippe adina*)	73	74	75	76	77	78	79	80	81	82	83
Stone crab (*Menippe mercenaria*) Bull shark (*Carcharhinus leucas*) Tarpon (*Megalops atlanticus*) Alabama shad (*Alosa alabamae*) Gulf menhaden (*Brevoortia patronus*) Yellowfin menhaden (*Brevoortia smithi*)	84	85	86	87	88	89	90	91	92	93	94
Gizzard shad (*Dorosoma cepedianum*) Bay anchovy (*Anchoa mitchilli*) Hardhead catfish (*Arius felis*) Sheepshead minnow (*Cyprinodon variegatus*) Gulf killifish (*Fundulus grandis*) Silversides (*Menidia* species)	95	96	97	98	99	100	101	102	103	104	105
Snook (*Centropomus undecimalis*) Bluefish (*Pomatomus saltatrix*) Blue runner (*Caranx crysos*) Crevalle jack (*Caranx hippos*) Florida pompano (*Trachinotus carolinus*) Gray snapper (*Lutjanus griseus*)	106	107	108	109	110	111	112	113	114	115	116
Sheepshead (*Archosargus probatocephalus*) Pinfish (*Lagodon rhomboides*) Silver perch (*Bairdiella chrysoura*) Sand seatrout (*Cynoscion arenarius*) Spotted seatrout (*Cynoscion nebulosus*) Spot (*Leiostomus xanthurus*)	117	118	119	120	121	122	123	124	125	126	127
Atlantic croaker (*Micropogonias undulatus*) Black drum (*Pogonias cromis*) Red drum (*Sciaenops ocellatus*) Striped mullet (*Mugil cephalus*) Code goby (*Gobiosoma robustum*) Spanish mackerel (*Scomberomorus maculatus*)	128	129	130	131	132	133	134	135	136	137	138
Gulf flounder (*Paralichthys albigutta*) Southern flounder (*Paralichthys lethostigma*)	139	140	141	142	143	144	145	146	147	148	149

Table 5. Temporal distribution



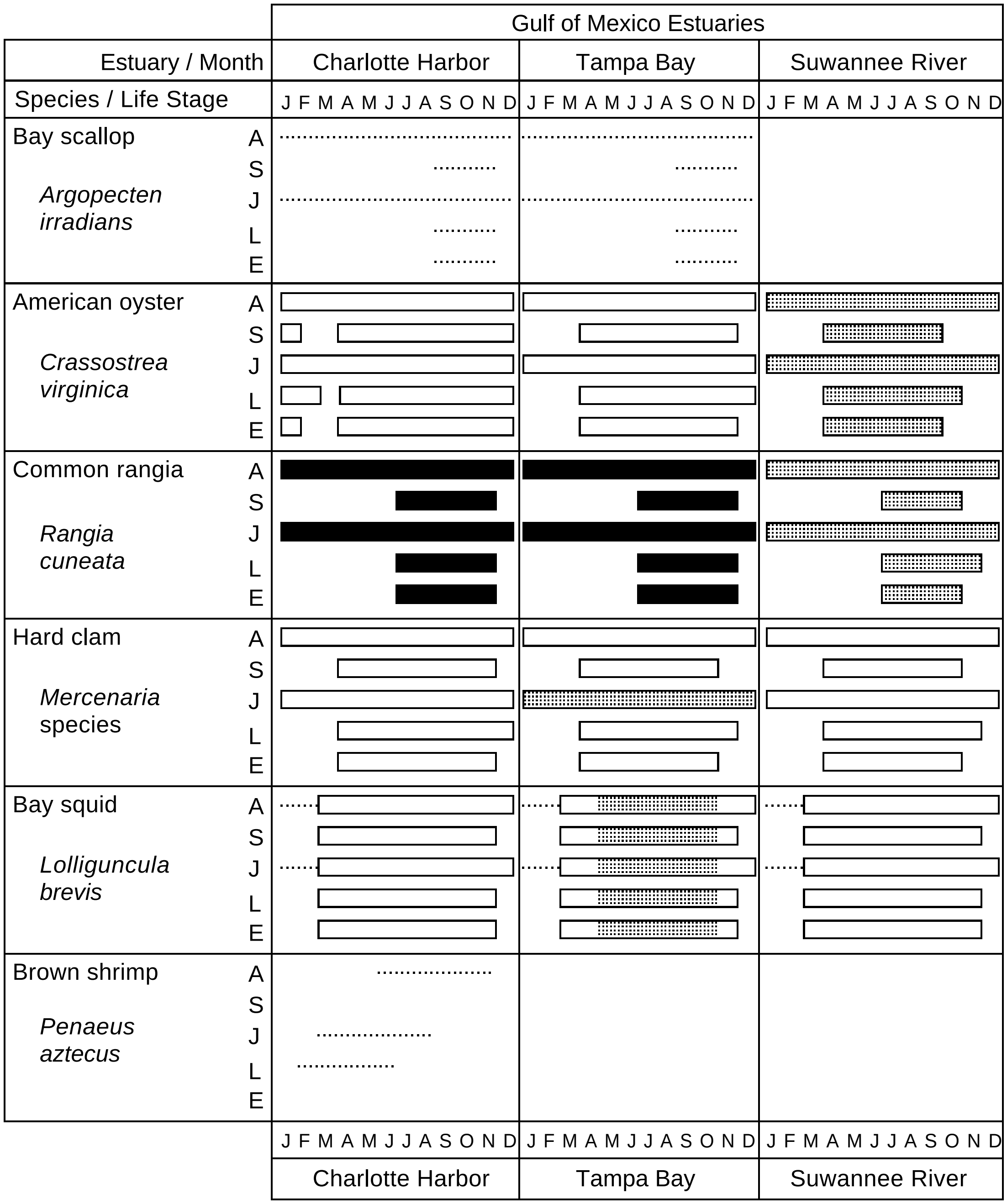
Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

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- Abundant
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Life Stage

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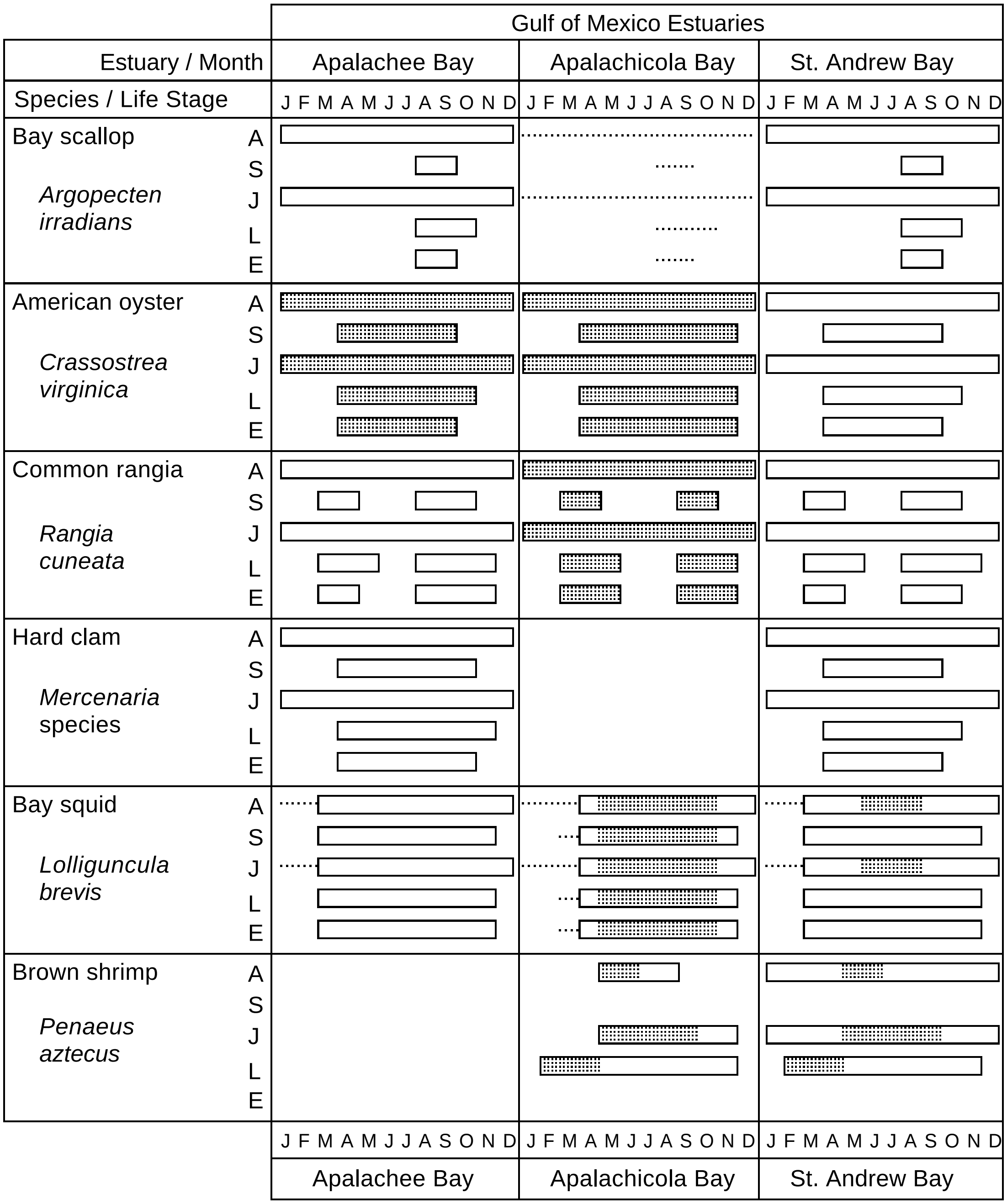
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

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Life Stage

A - Adults
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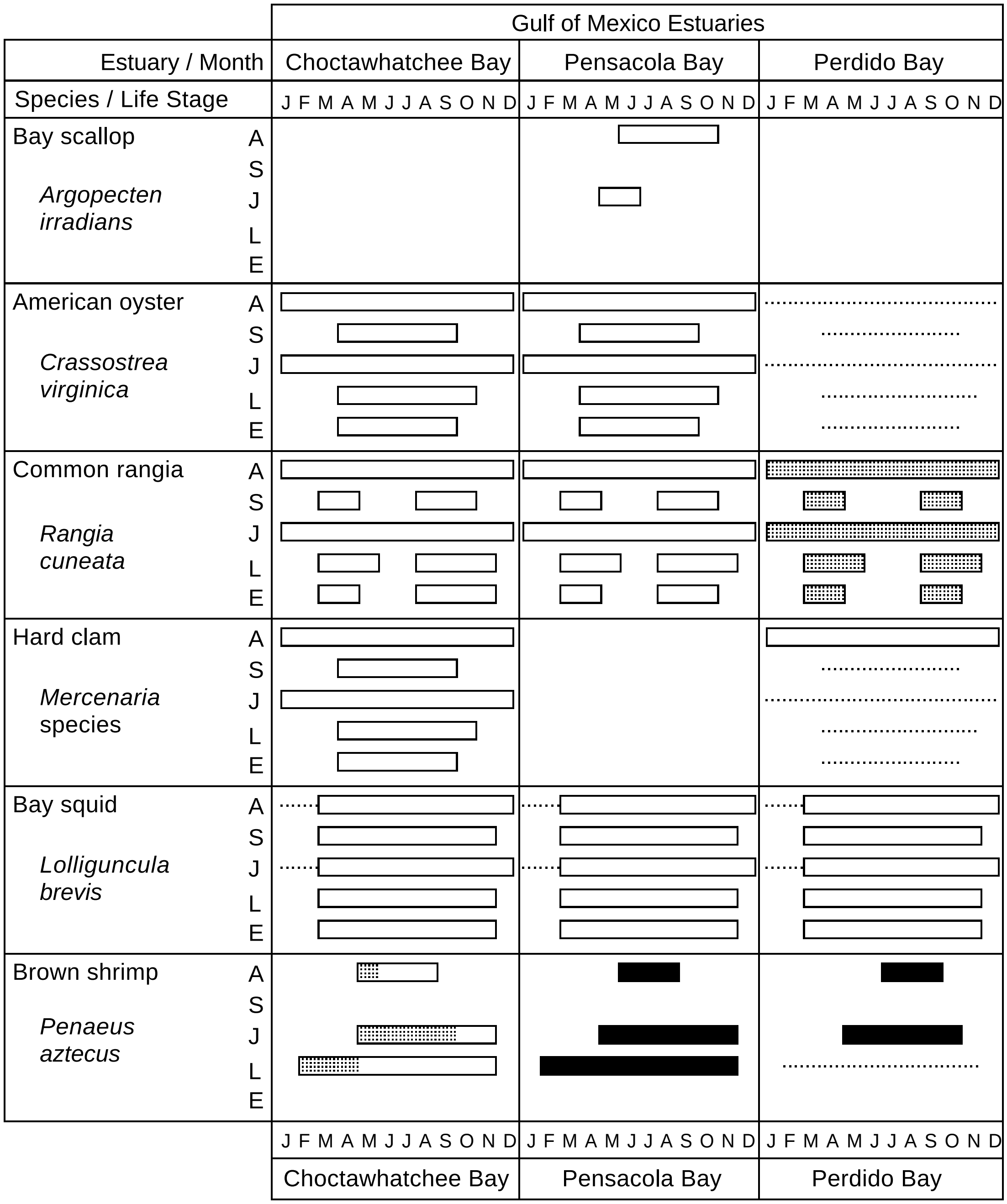
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

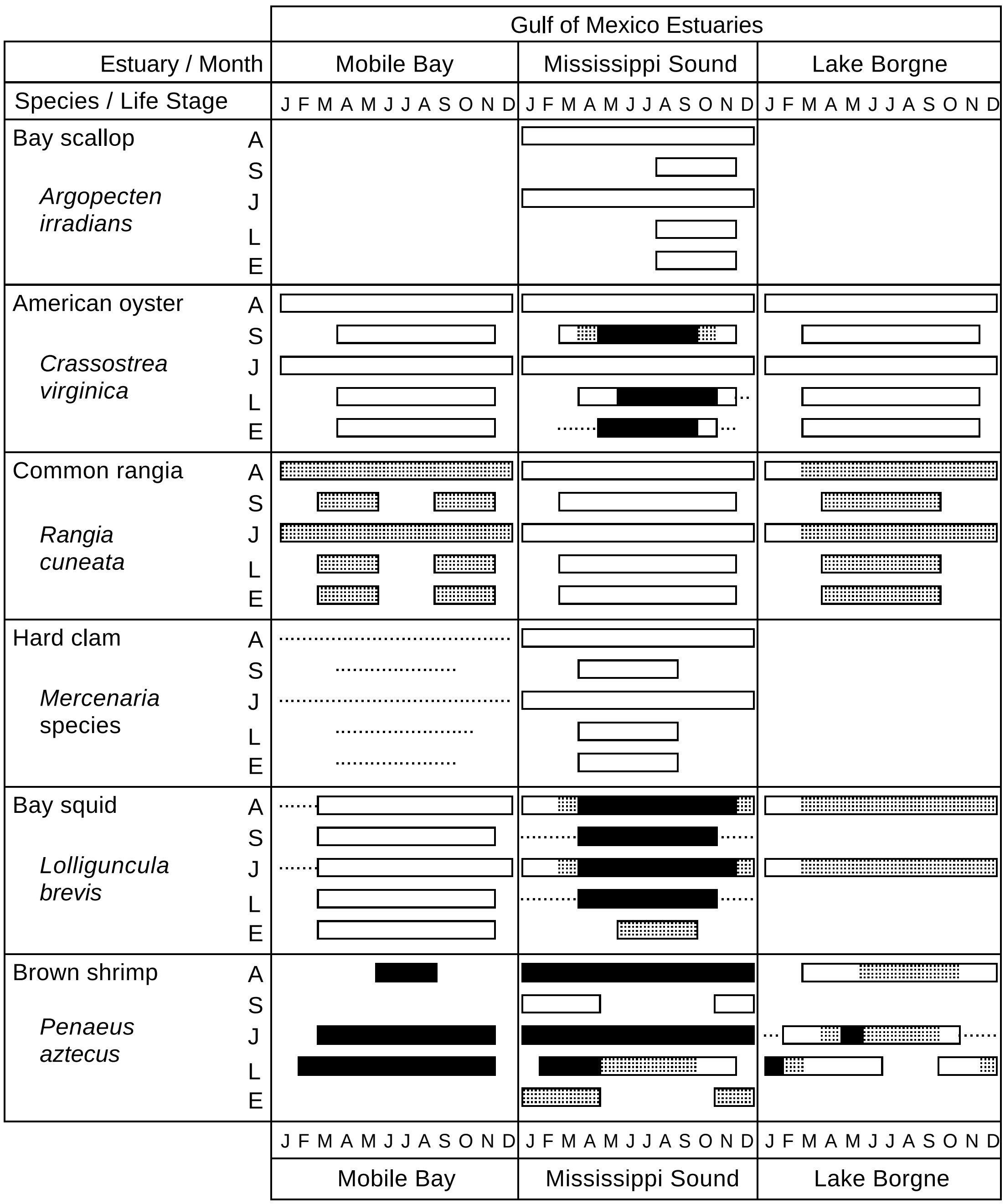
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

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Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
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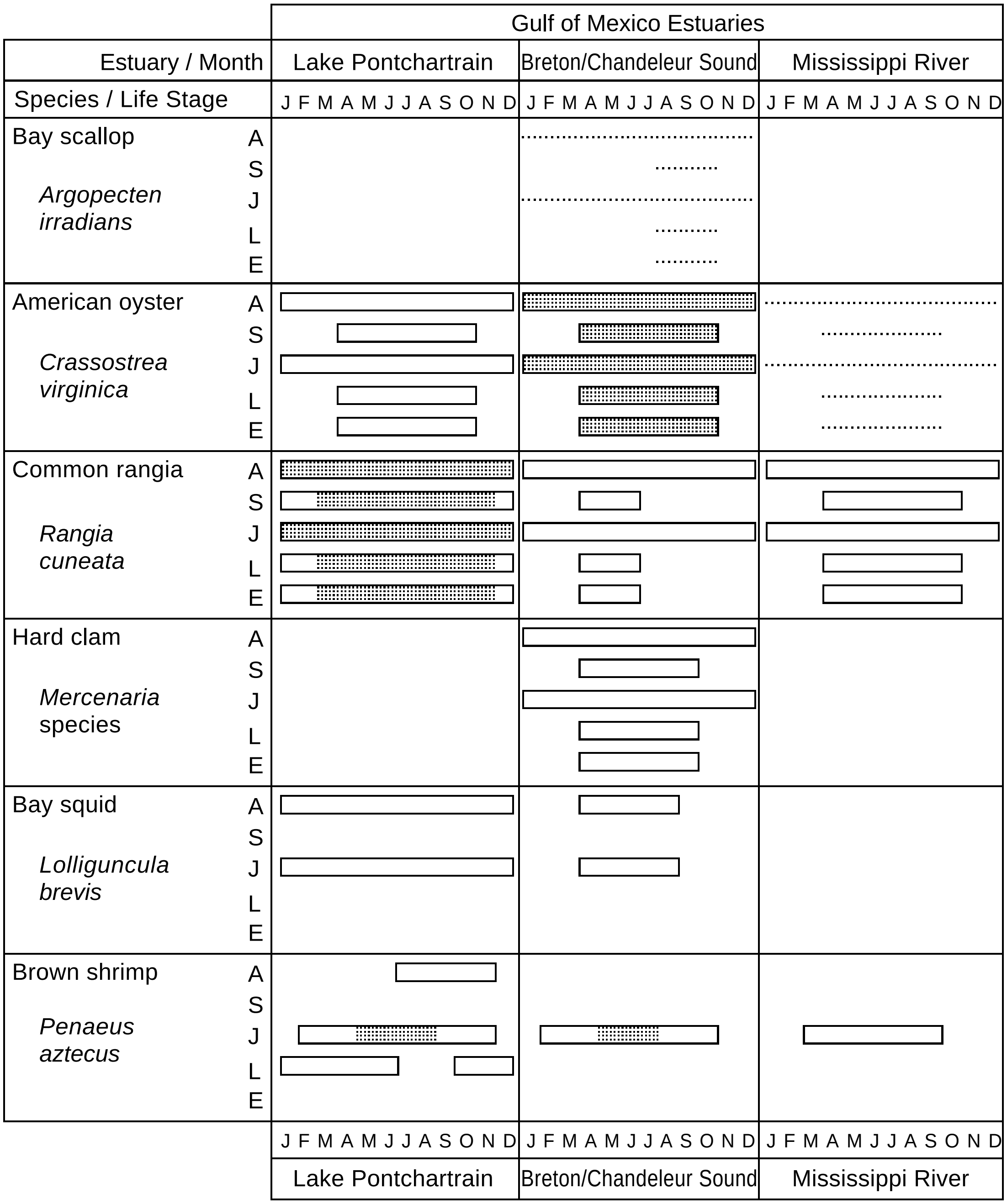
Table 5, continued. Temporal distribution



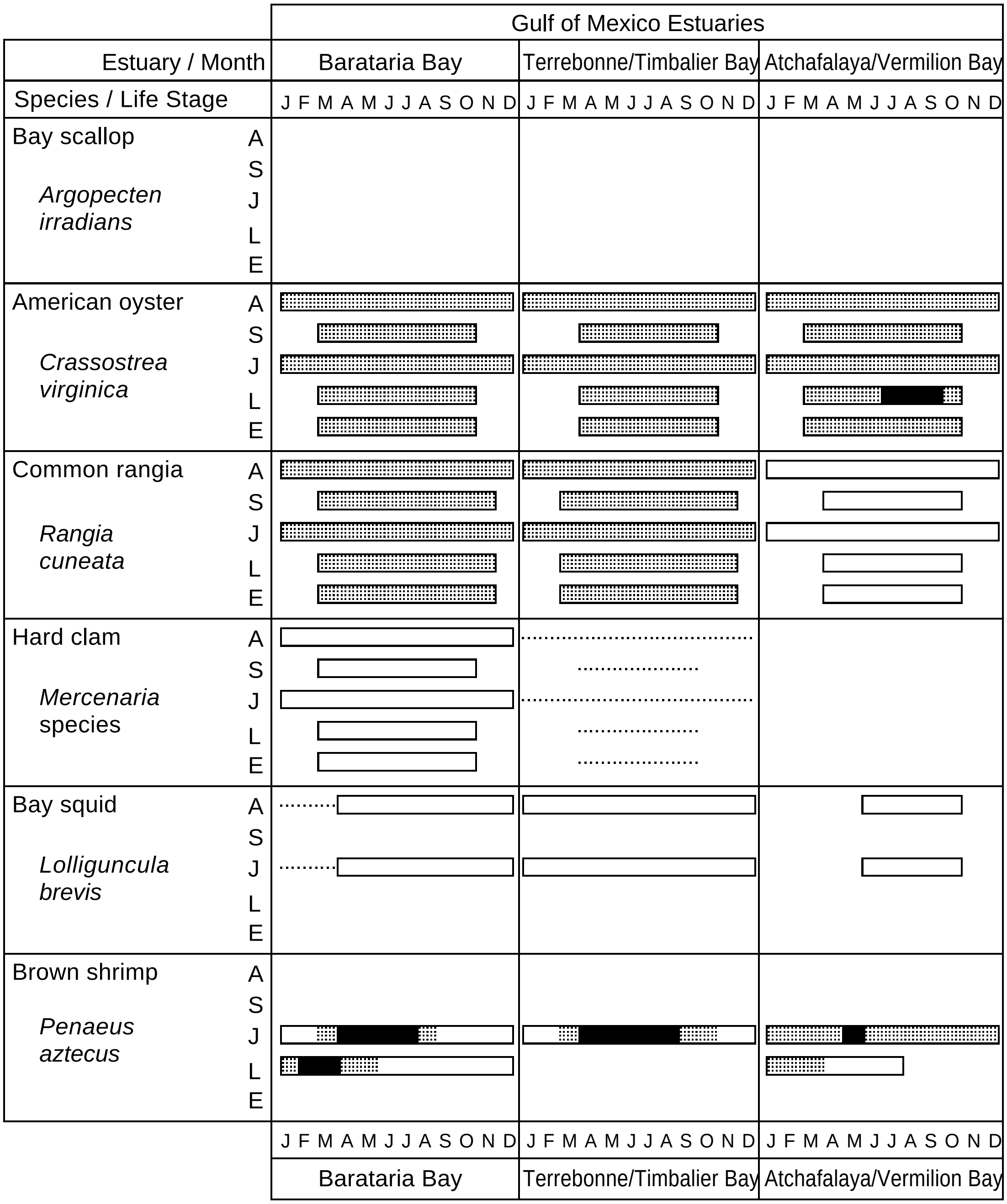
Relative Abundance

■	Highly Abundant
▦	Abundant
□	Common
....	Rare
Blank	Not Present

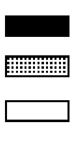
Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance



Highly Abundant

Abundant

Common

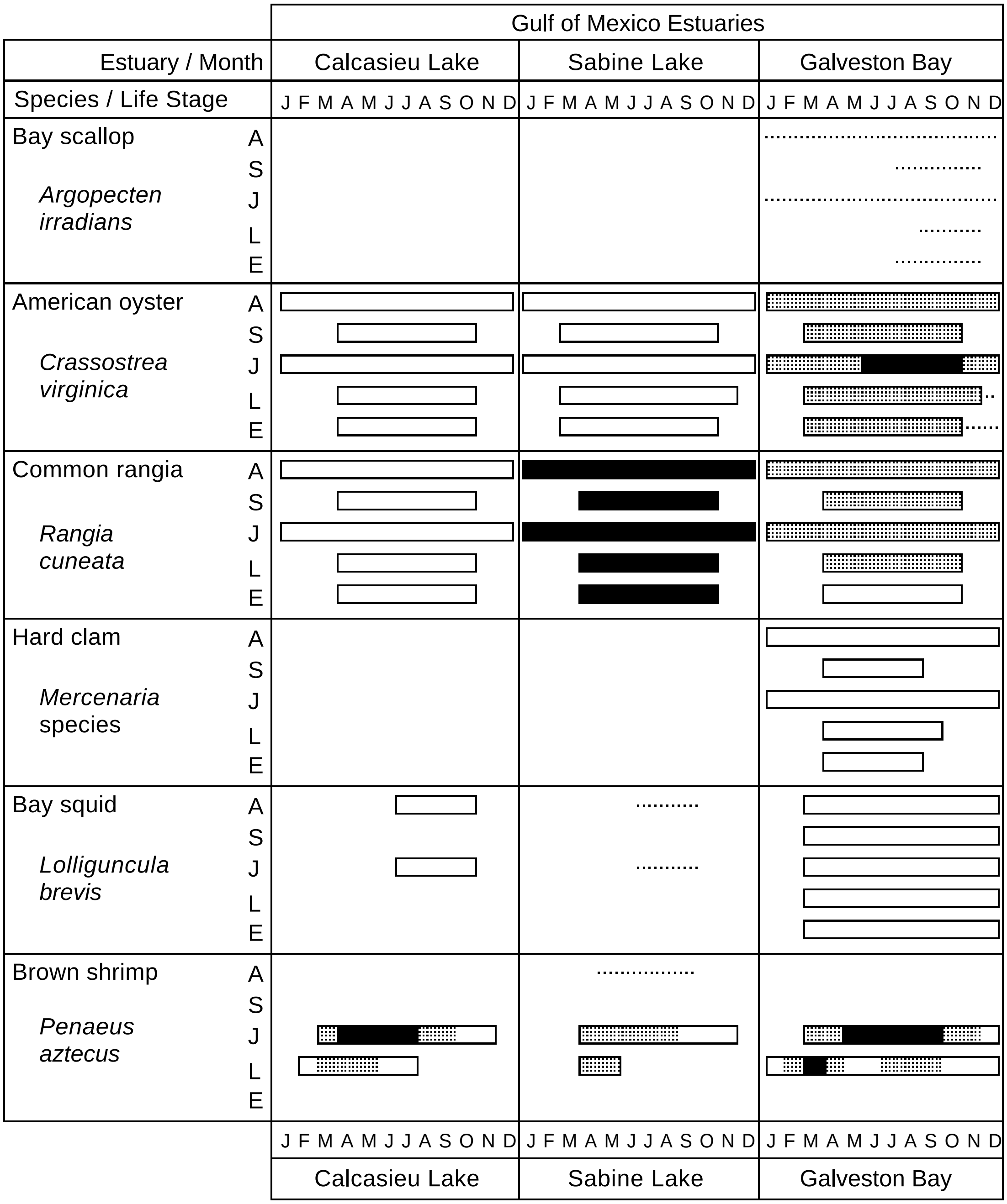
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



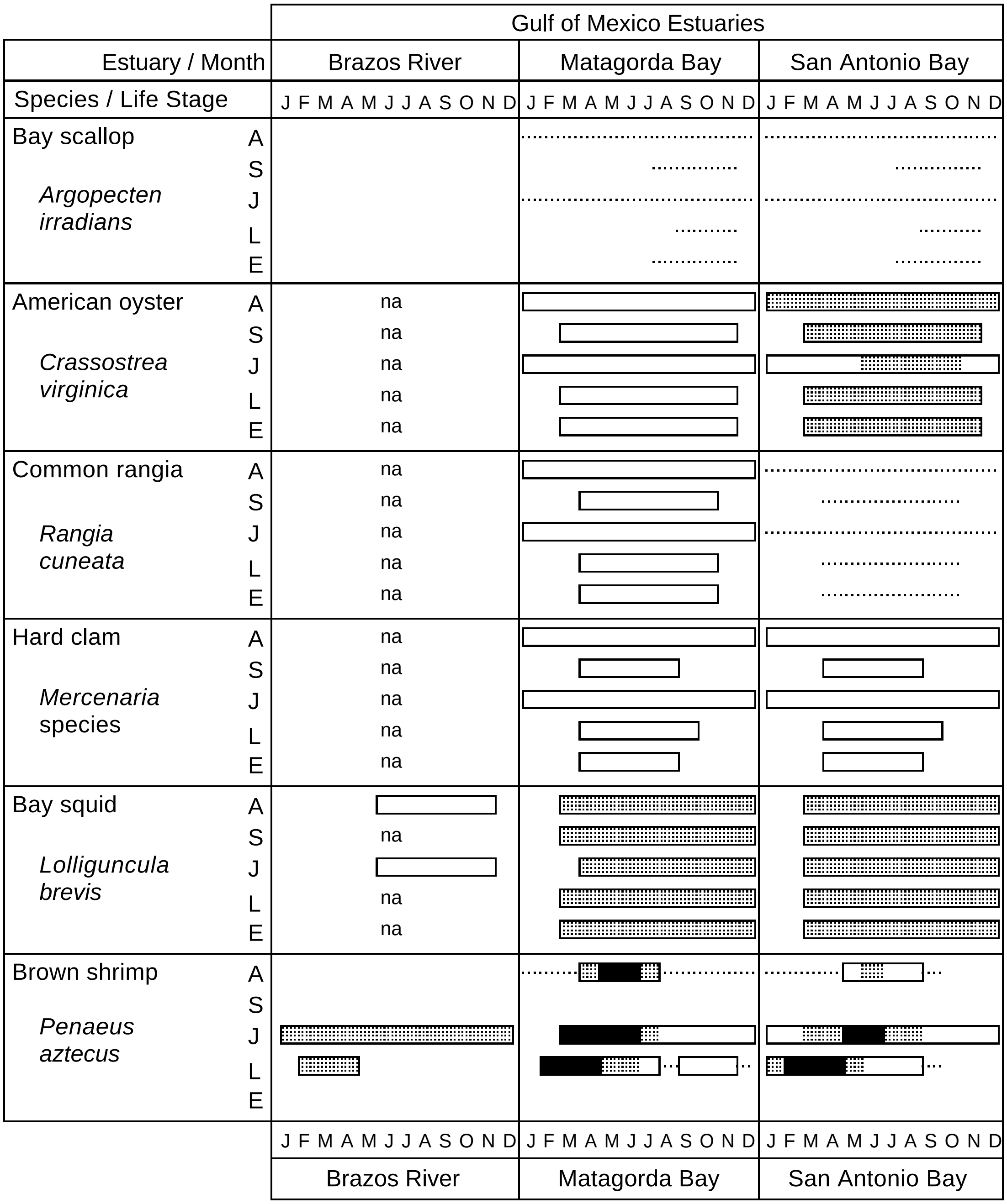
Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank — Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

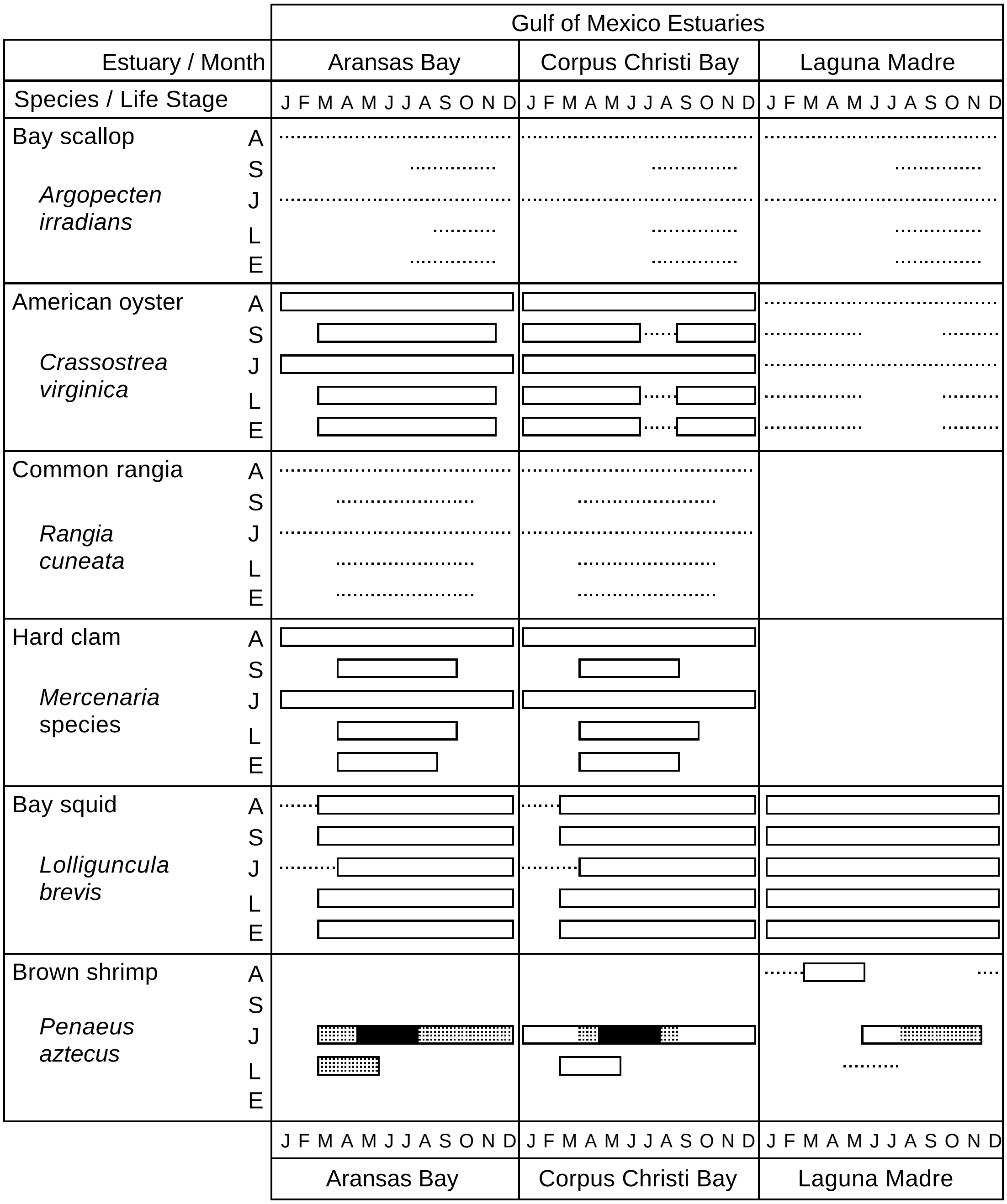
Blank Not Present

n No Data Available

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution

Estuary / Month		Gulf of Mexico Estuaries: Baffin Bay
Species / Life Stage		J F M A M J J A S O N D
Bay scallop *Argopecten irradians*	A	
	S	
	J	
	L	
	E	
American oyster *Crassostrea virginica*	A	
	S	
	J	
	L	
	E	
Common rangia *Rangia cuneata*	A	
	S	
	J	
	L	
	E	
Hard clam *Mercenaria* species	A	
	S	
	J	
	L	
	E	
Bay squid *Lolliguncula brevis*	A	
	S	
	J	
	L	
	E	
Brown shrimp *Penaeus aztecus*	A	
	S	
	J	
	L	
	E	
		J F M A M J J A S O N D
		Baffin Bay

Relative Abundance

Highly Abundant

Abundant

Common

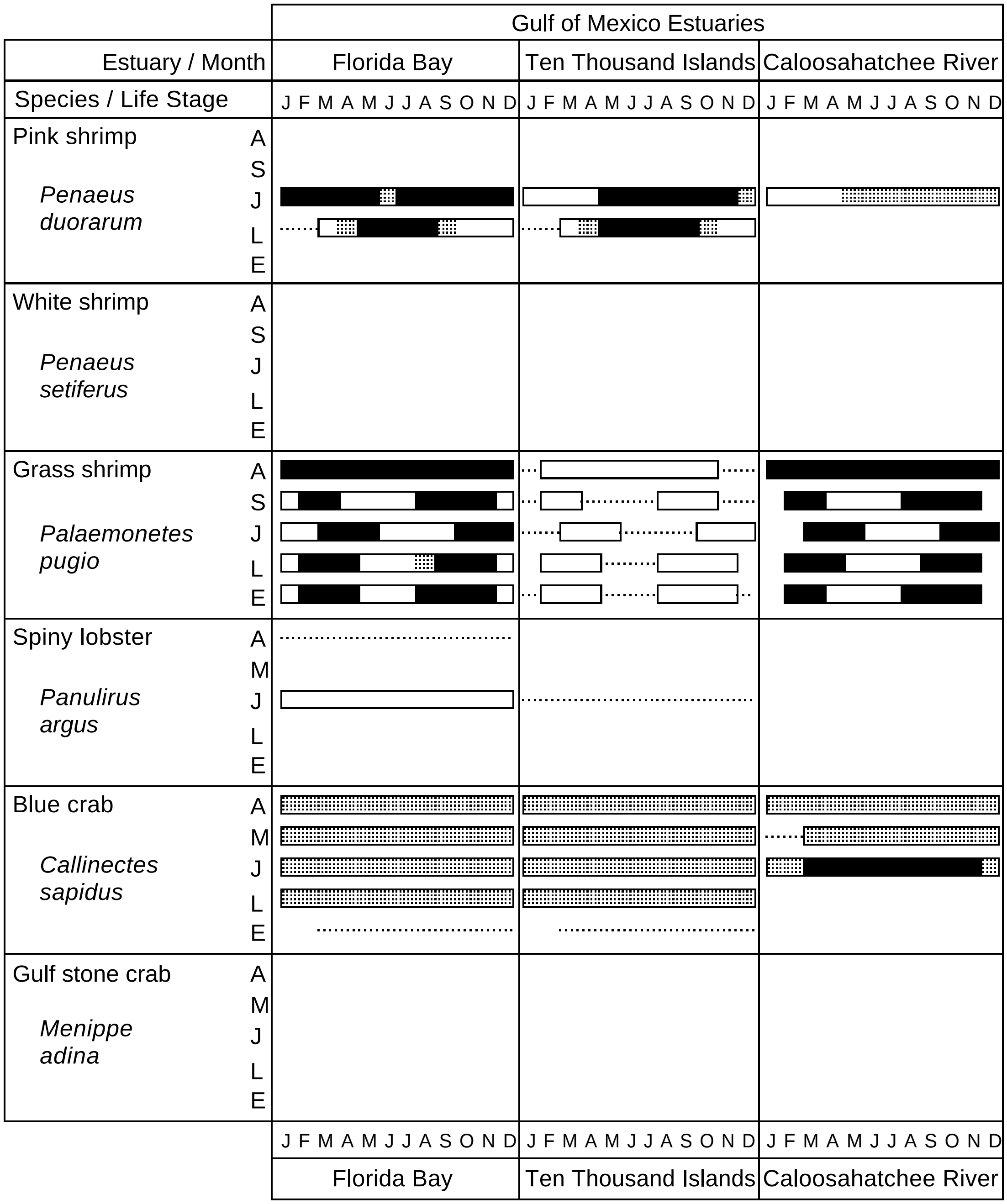
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

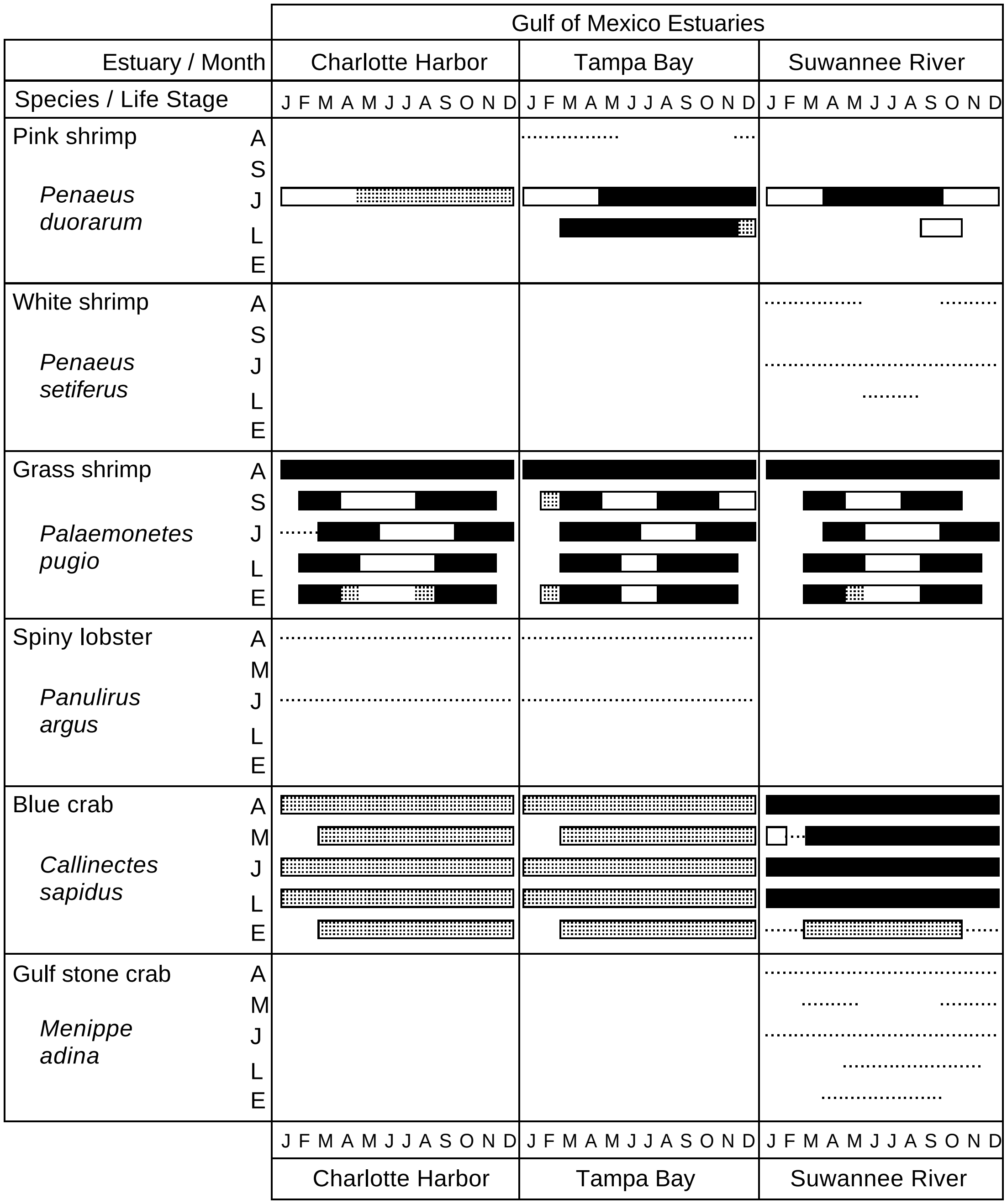
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

Blank — Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 5, continued. Temporal distribution

Relative Abundance

Highly Abundant

Abundant

Common

Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
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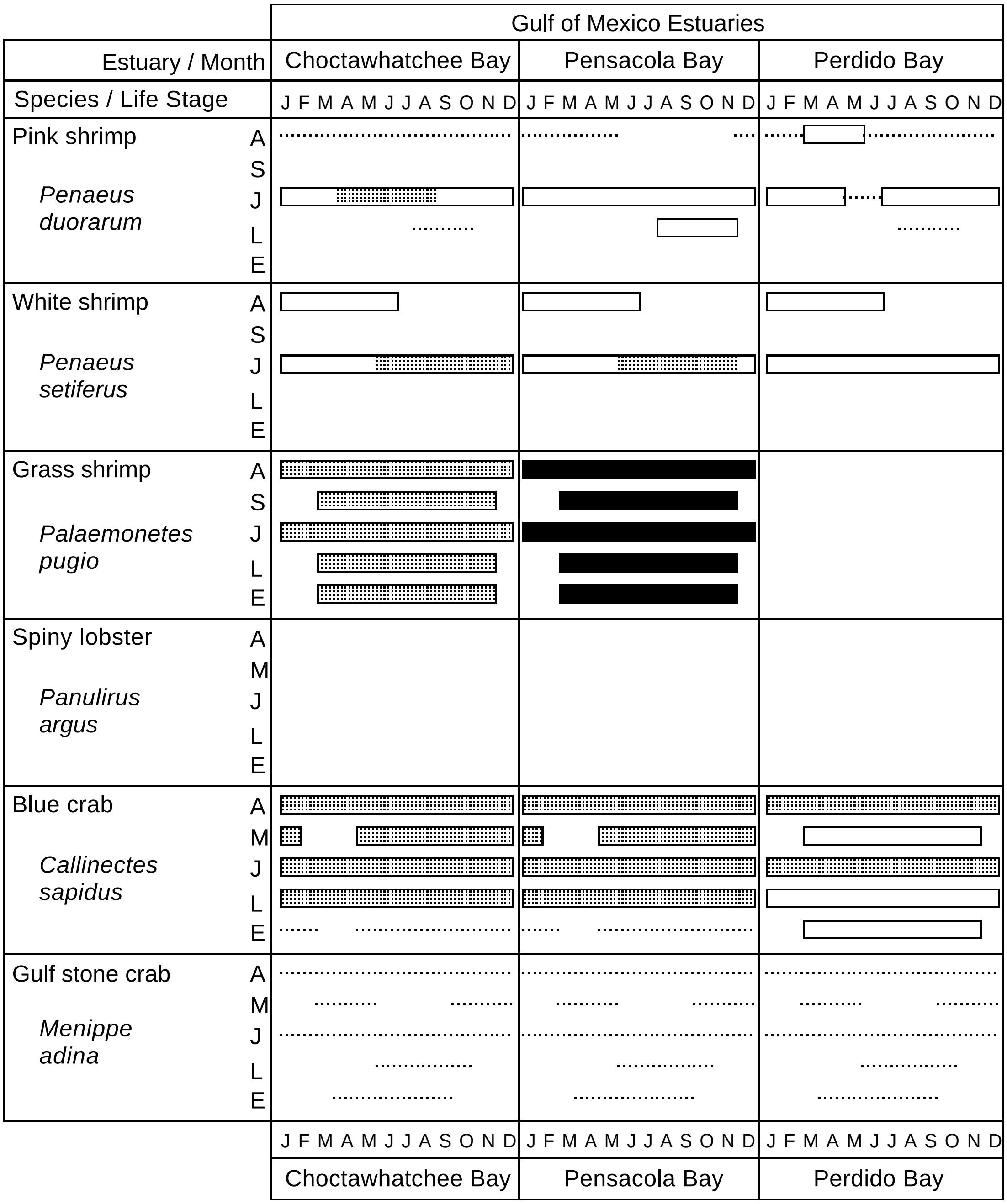
Table 5, continued. Temporal distribution



Relative Abundance

- Highly Abundant
- Abundant
- Common
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Life Stage

A - Adults
S - Spawning adults
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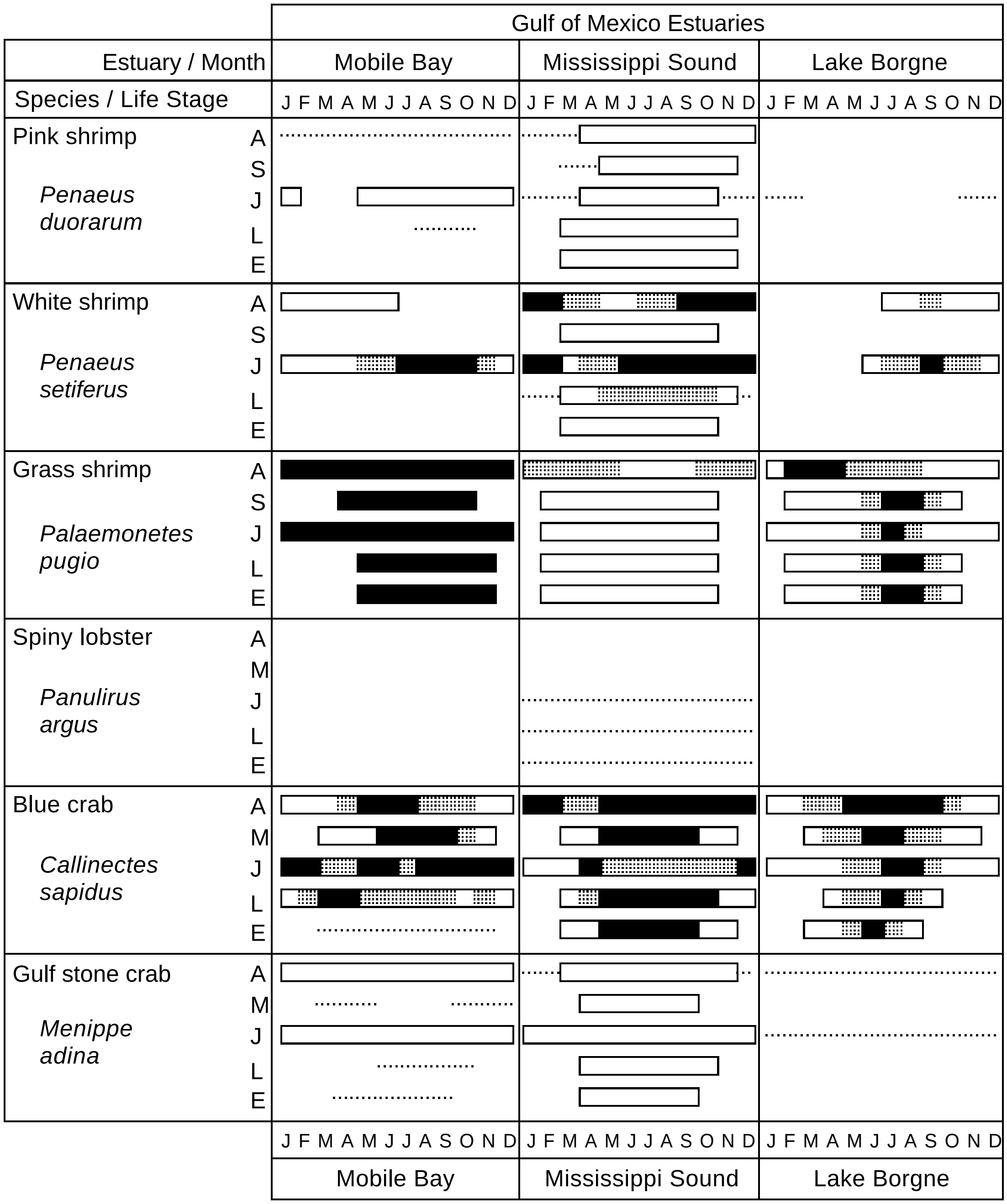
E - Eggs
M - Mating

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

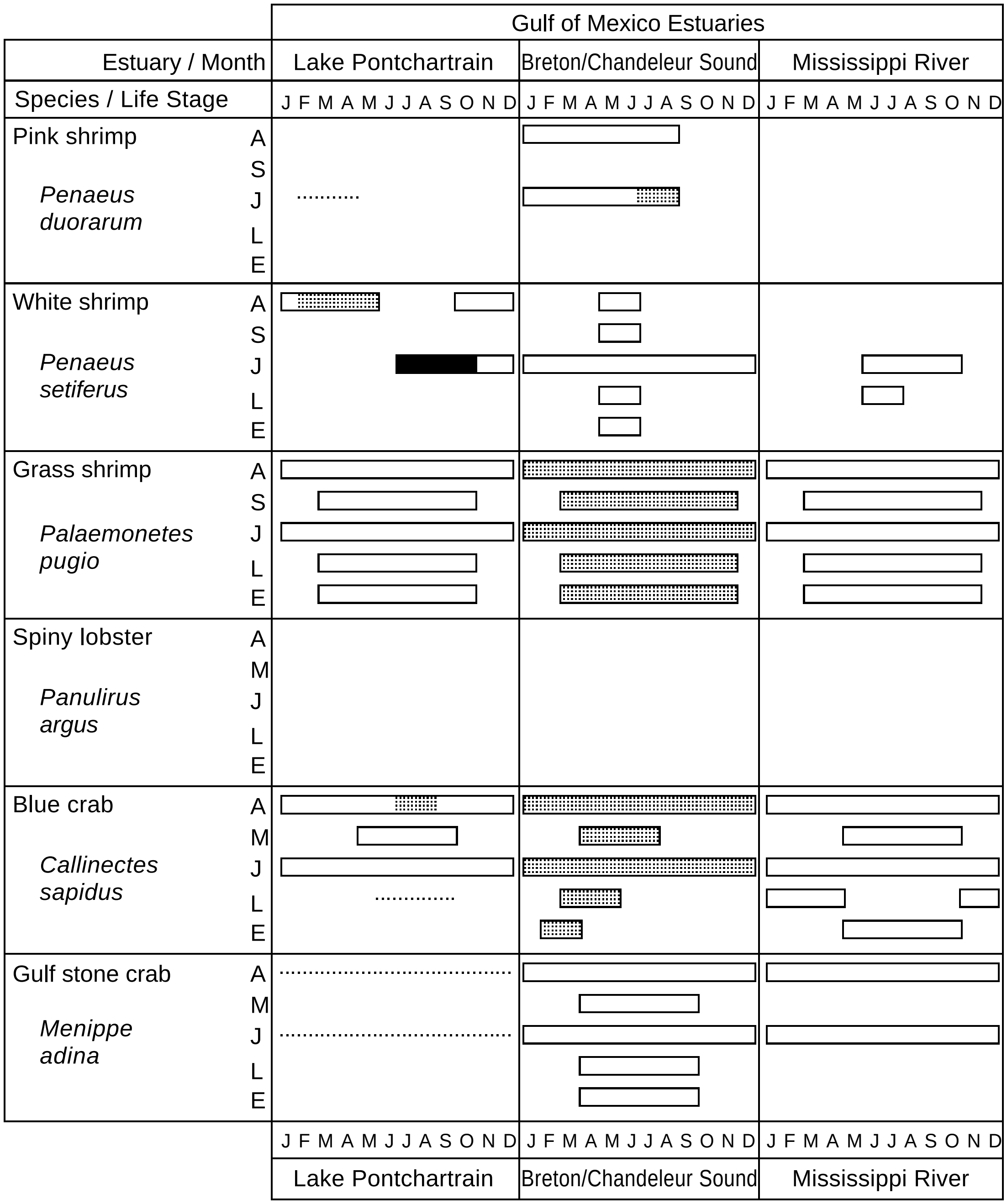
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 5, continued. Temporal distribution



Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank — Not Present

Life Stage

A - Adults
S - Spawning adults
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E - Eggs
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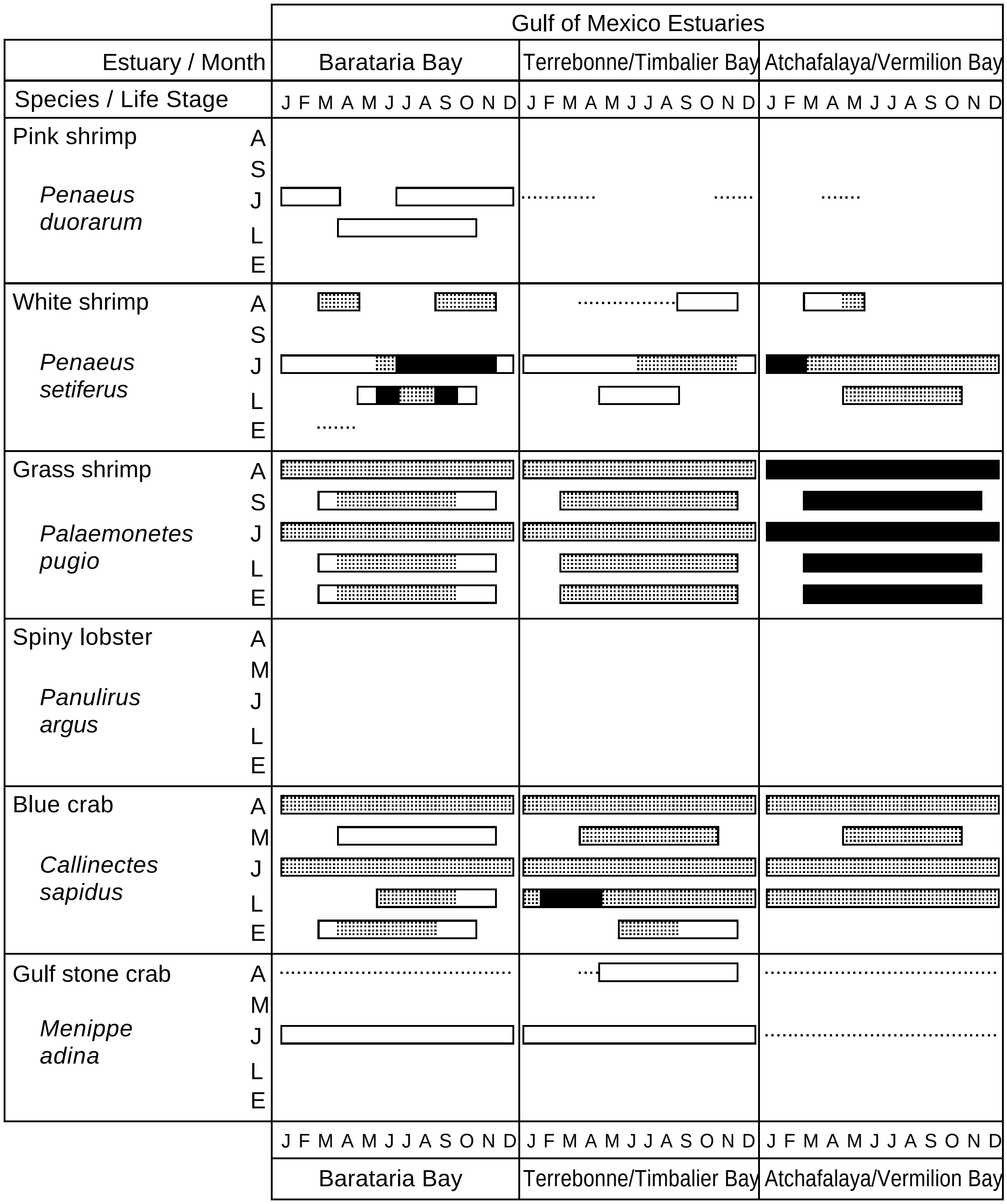
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

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Life Stage

A - Adults
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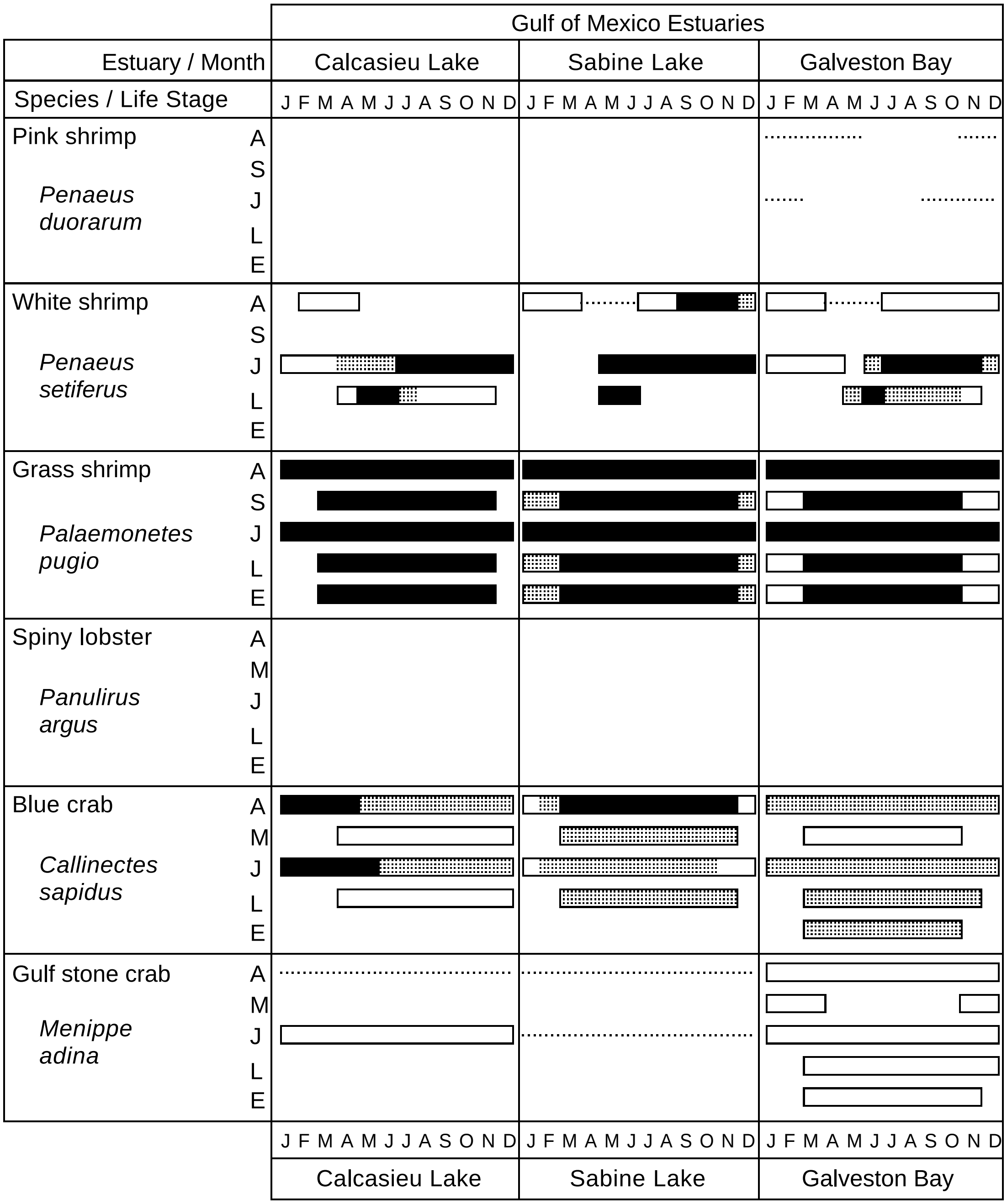
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

.... Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
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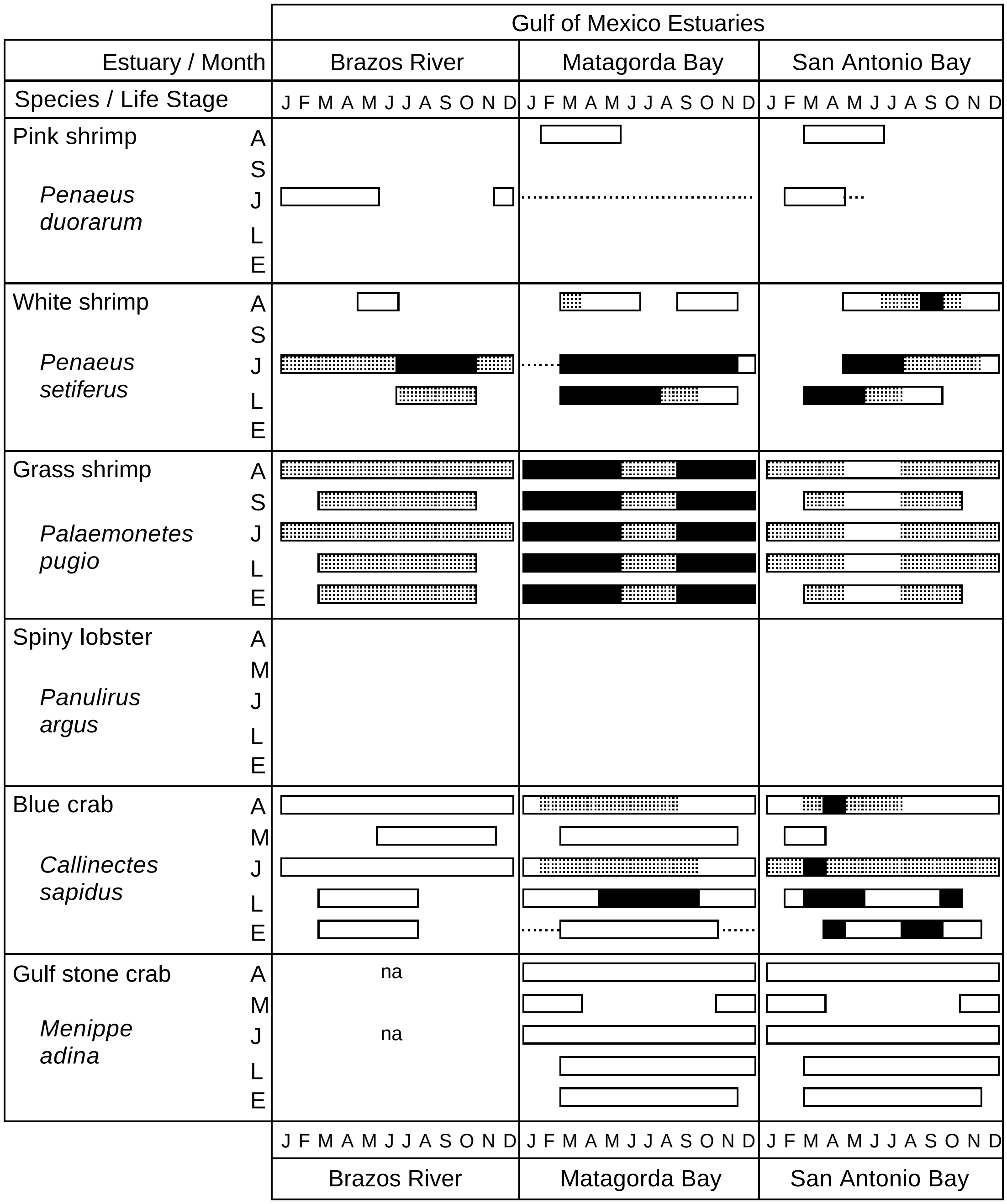
L - Larvae
E - Eggs
M - Mating

Table 5, continued. Temporal distribution



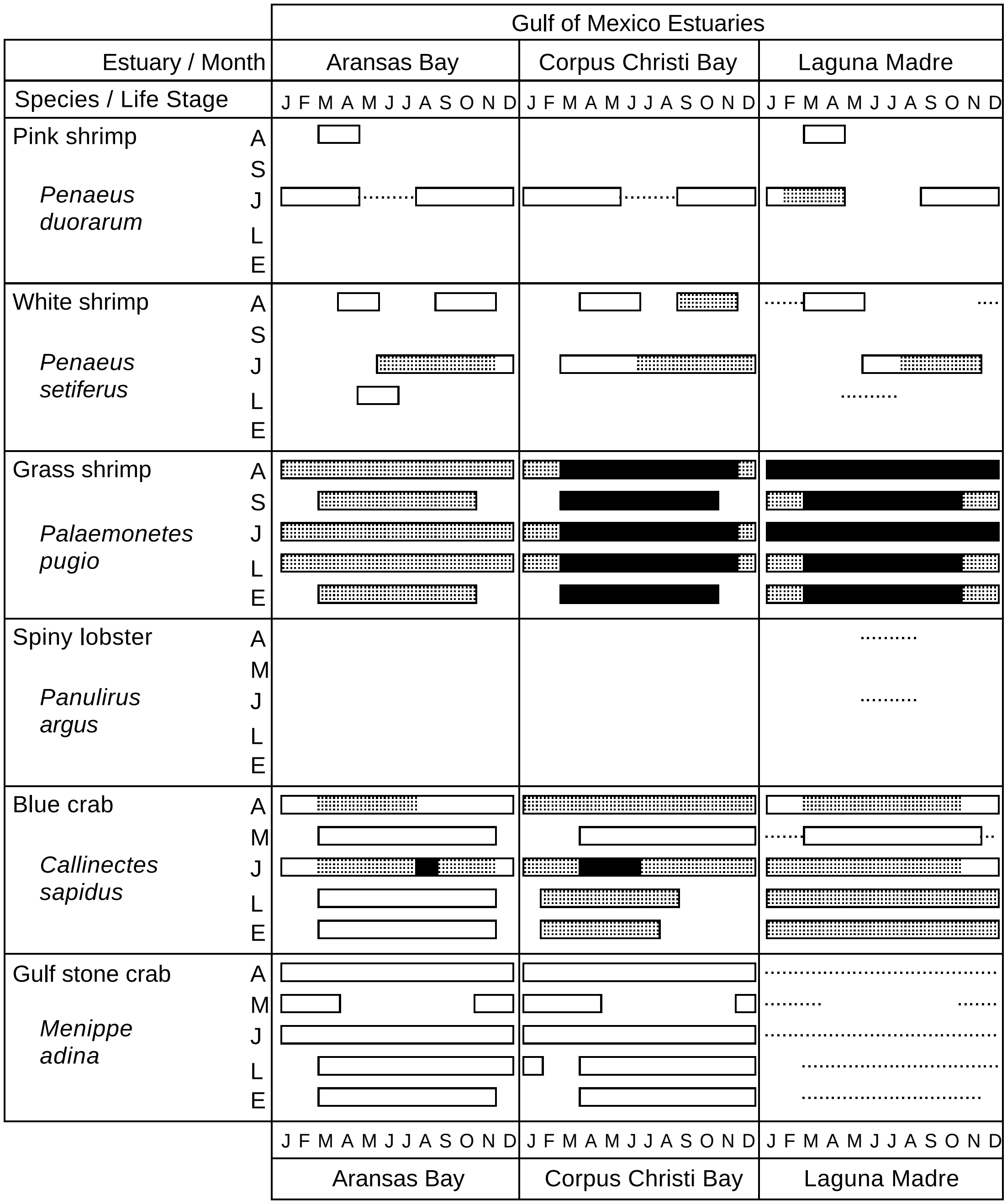
Relative Abundance

	Highly Abundant
	Abundant
	Common
....	Rare
Blank	Not Present
n	No Data Available

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 5, continued. Temporal distribution



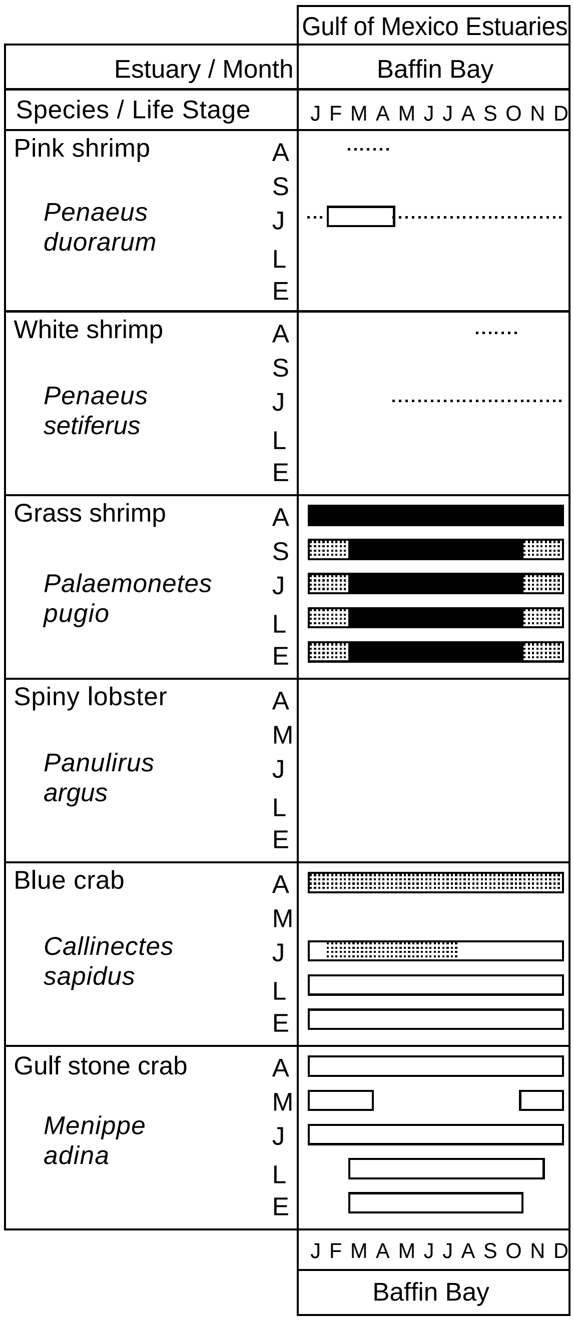
Relative Abundance

- (black bar) Highly Abundant
- (stippled bar) Abundant
- (open bar) Common
- .... Rare
- Blank — Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

Blank Not Present

Life Stage

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S - Spawning adults
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L - Larvae
E - Eggs
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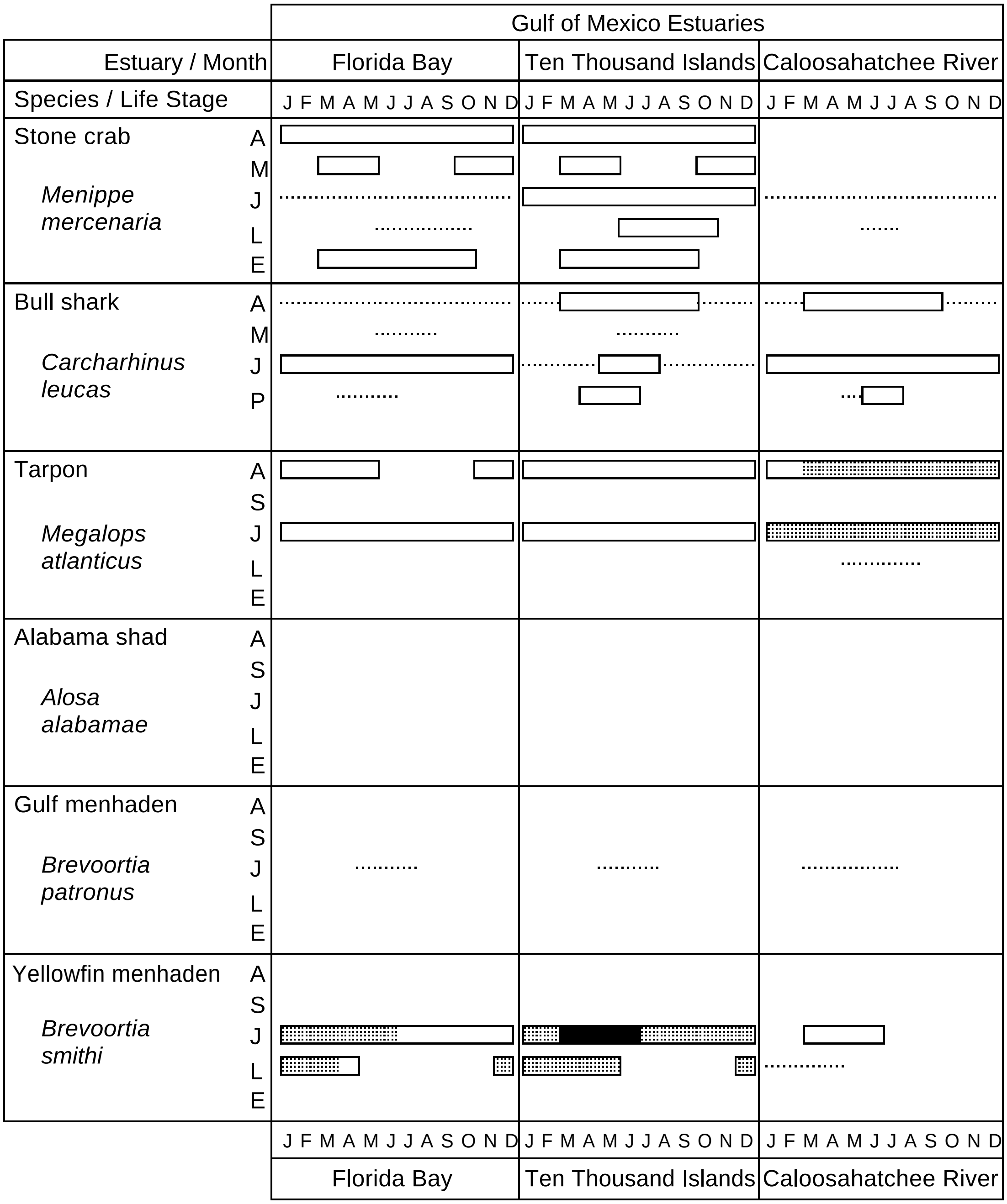
Table 5, continued. Temporal distribution



Relative Abundance

- Highly Abundant
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Life Stage

A - Adults
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J - Juveniles
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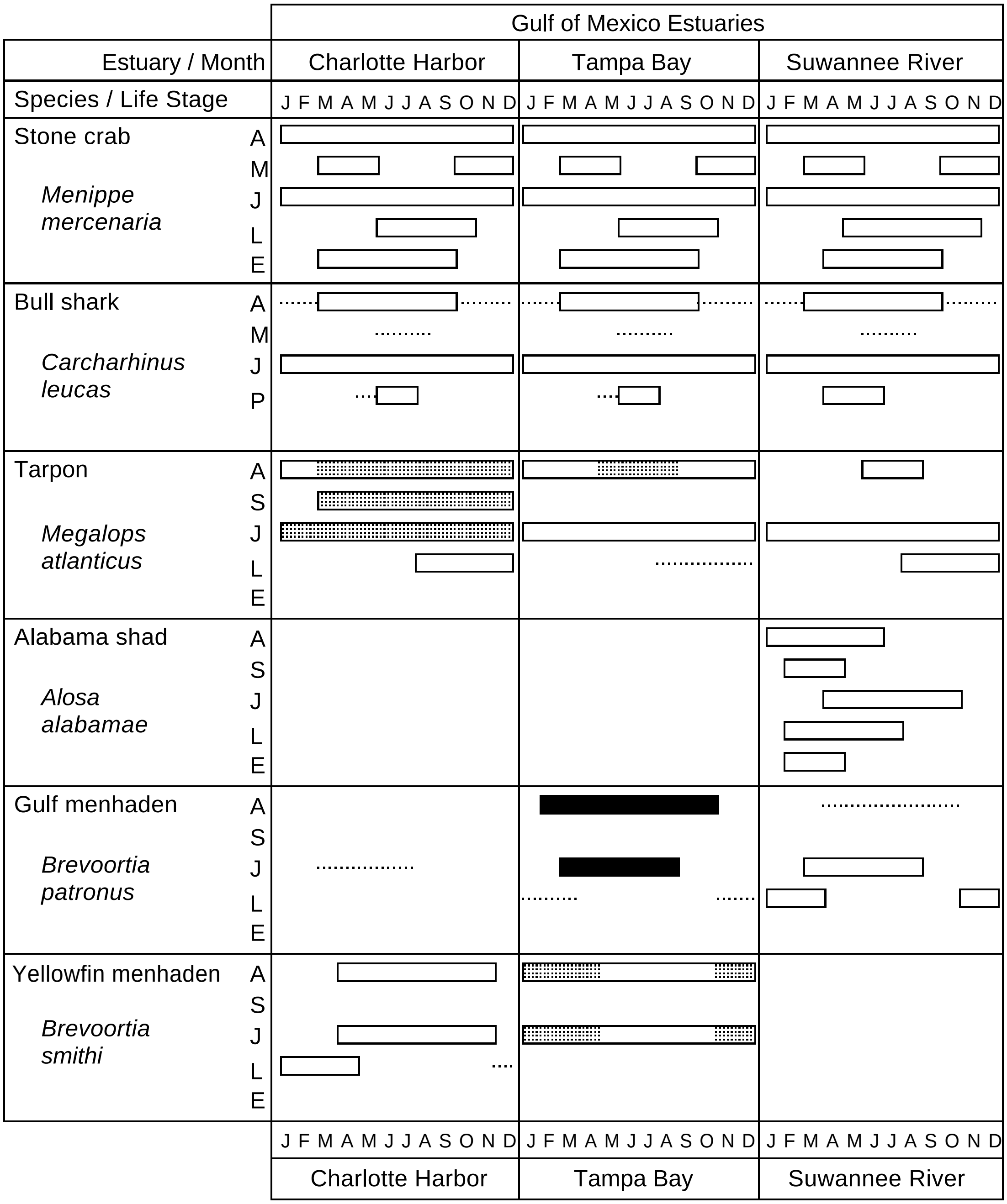
E - Eggs
M - Mating
P - Parturition

Table 5, continued. Temporal distribution



Relative Abundance

■	Highly Abundant
▒	Abundant
□	Common
....	Rare
Blank	Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
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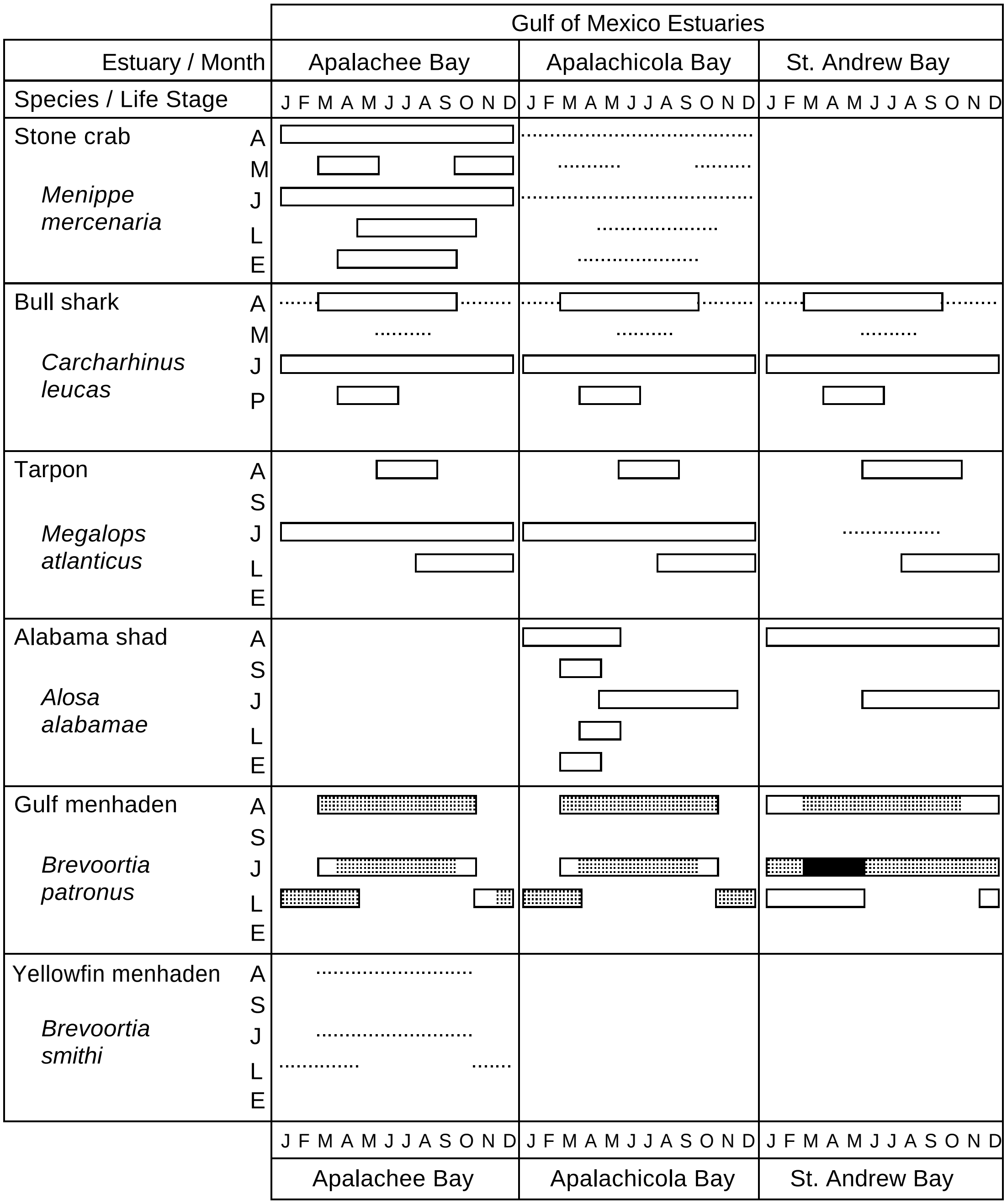
P - Parturition

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

Blank — Not Present

Life Stage

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L - Larvae
E - Eggs
M - Mating
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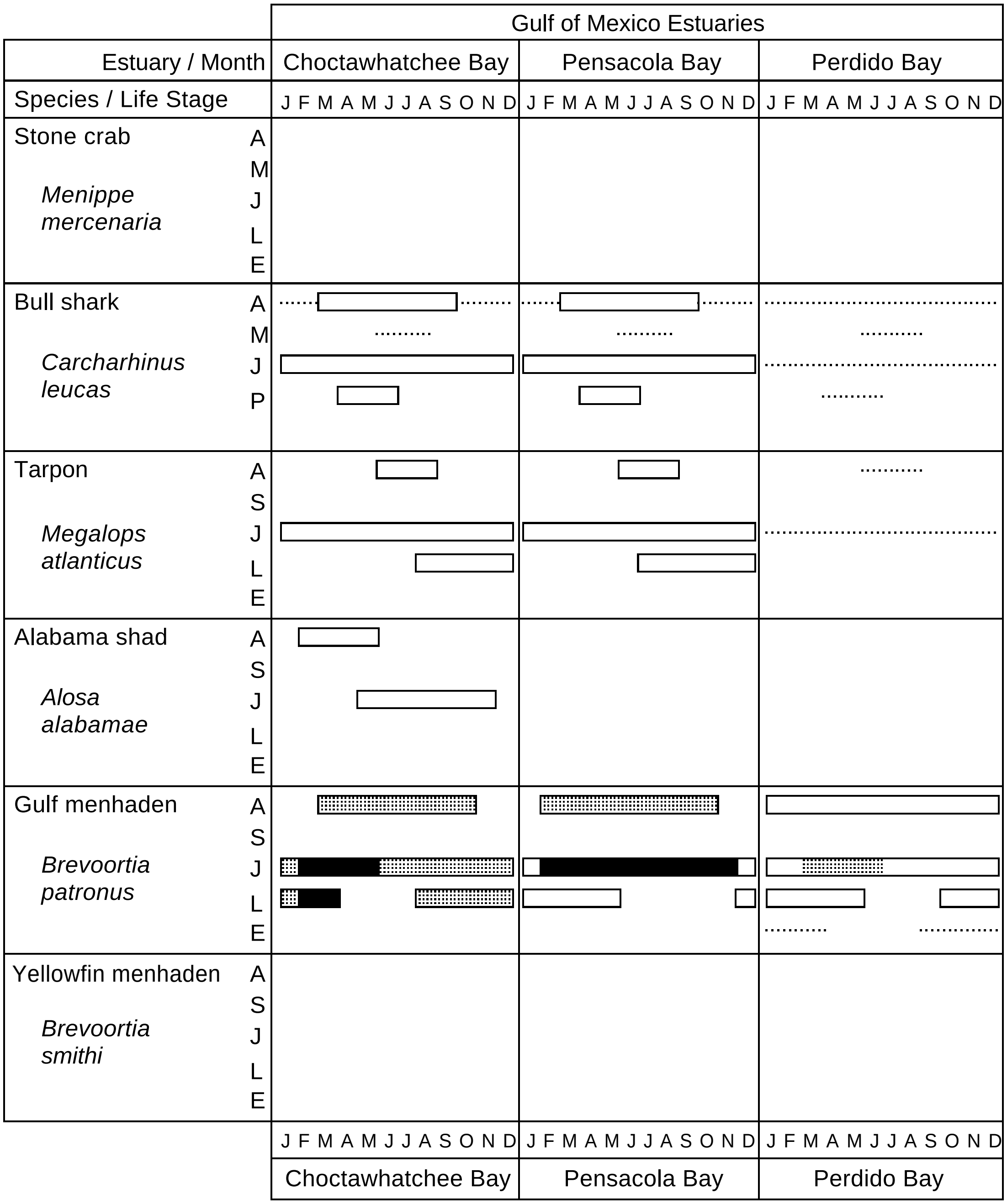
Table 5, continued. Temporal distribution



Relative Abundance

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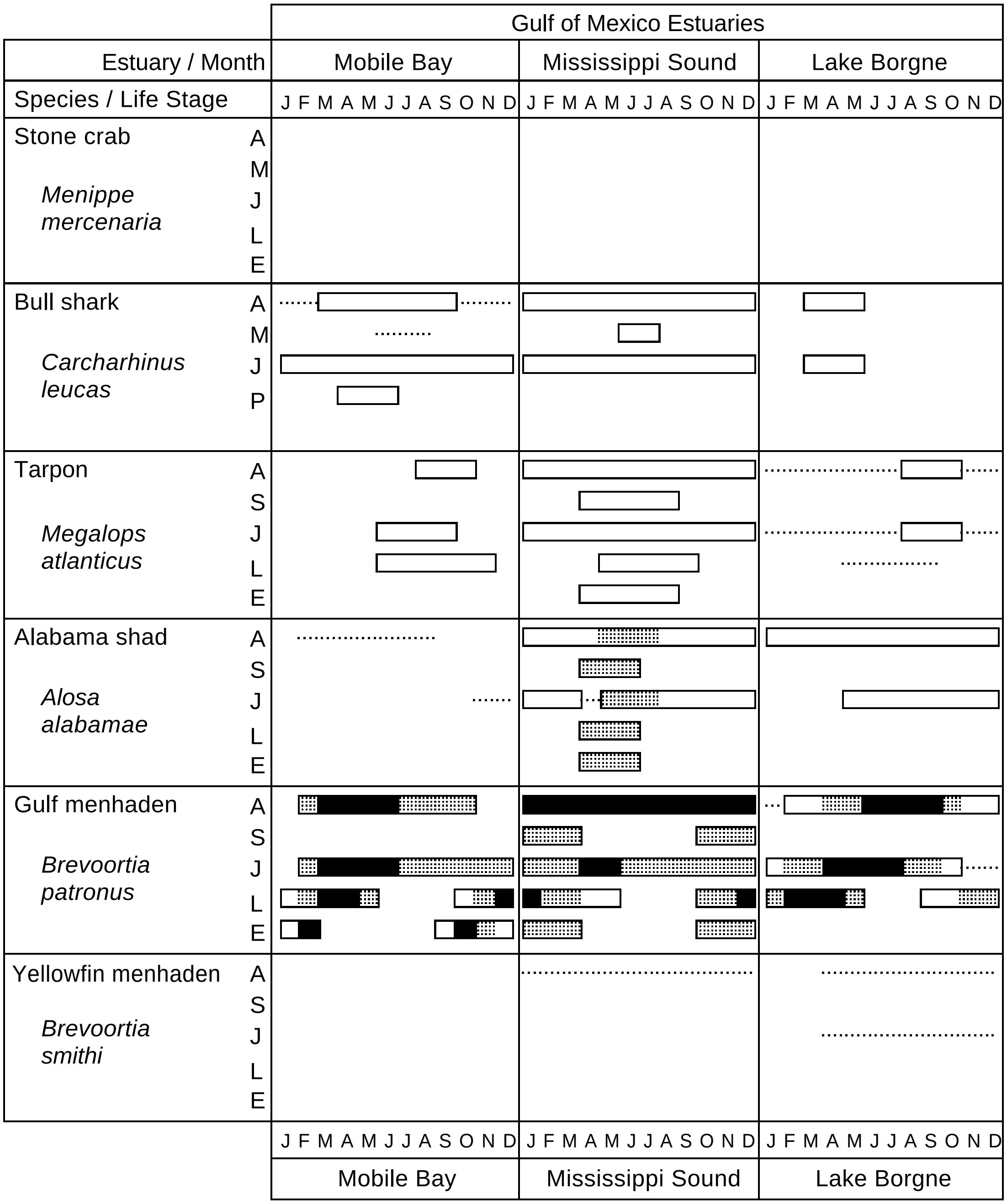
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

Blank   Not Present

Life Stage

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Table 5, continued. Temporal distribution

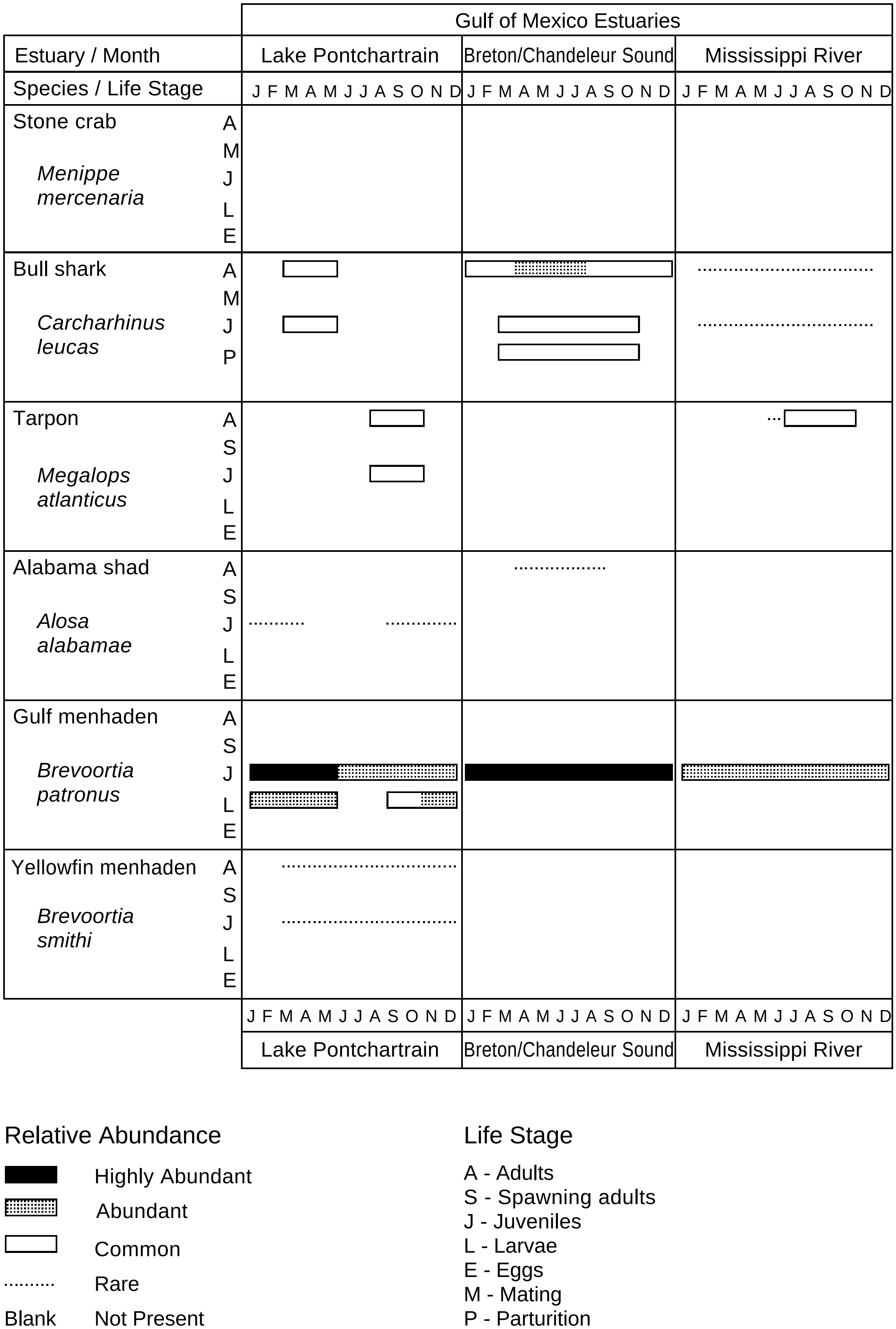
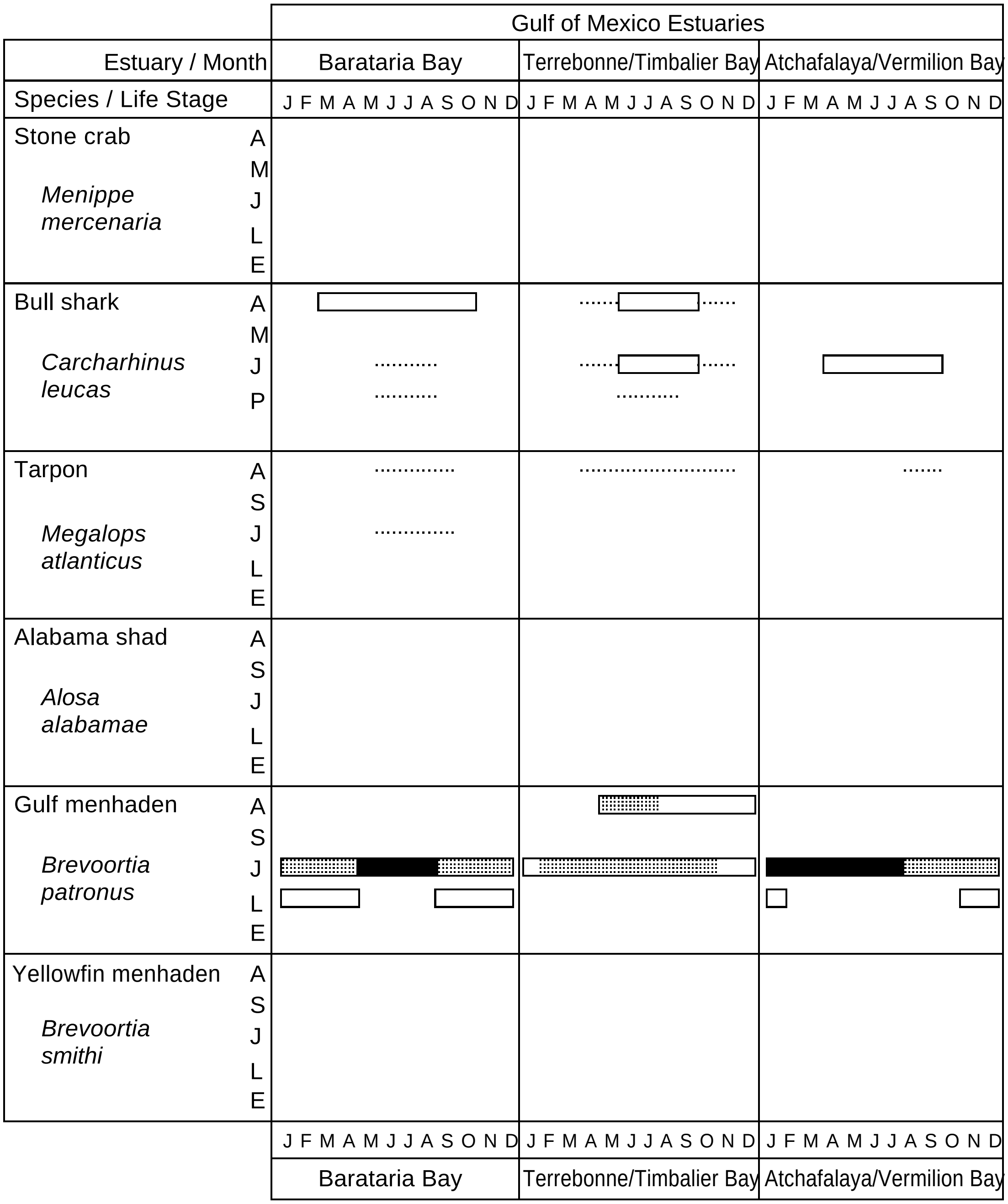


Table 5, continued. Temporal distribution



Relative Abundance

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- Abundant
- Common
- .... Rare
- Blank Not Present

Life Stage

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S - Spawning adults
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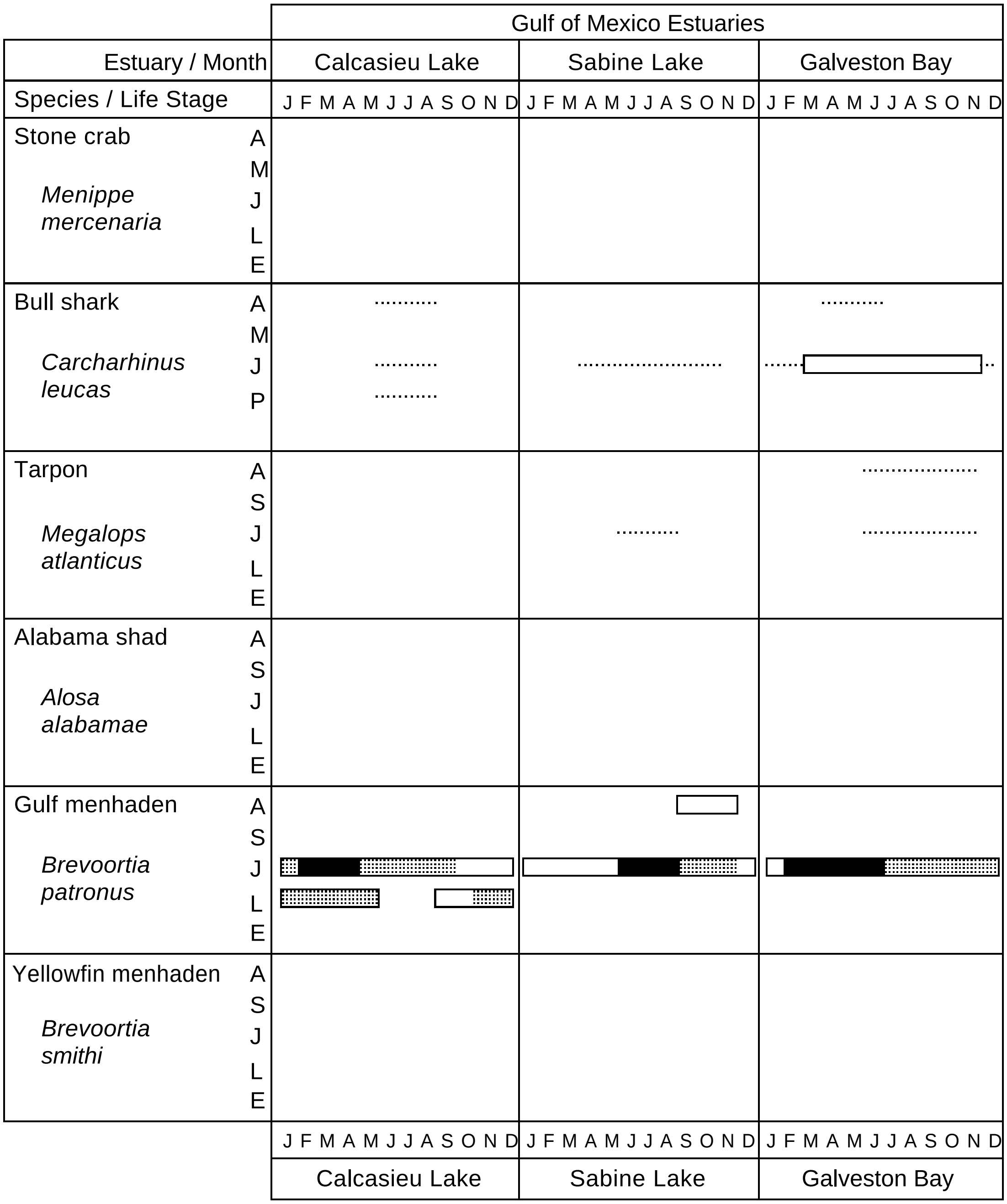
Table 5, continued. Temporal distribution



Relative Abundance

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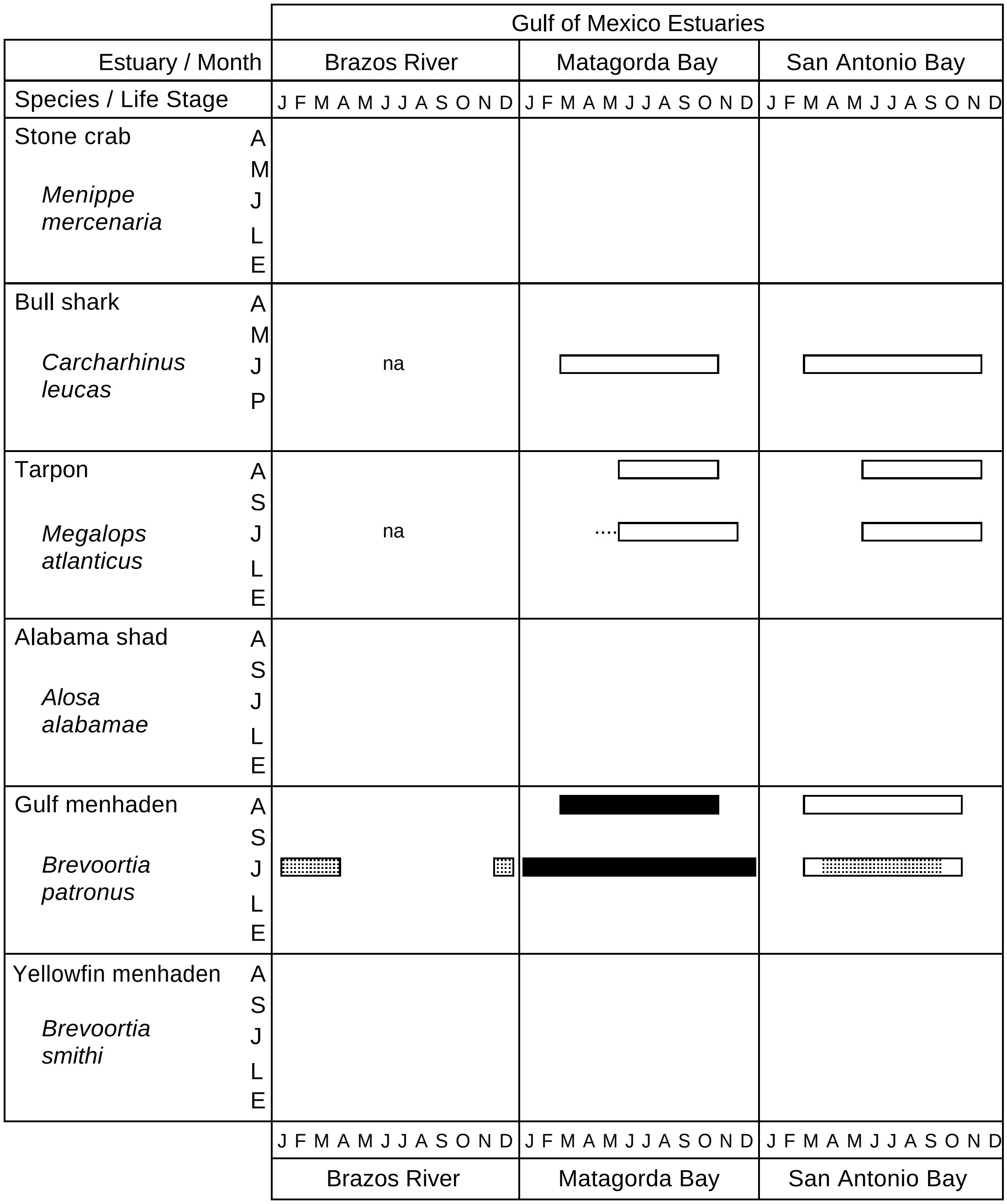
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

.... Rare

Blank Not Present

n No Data Available

Life Stage

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S - Spawning adults
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L - Larvae
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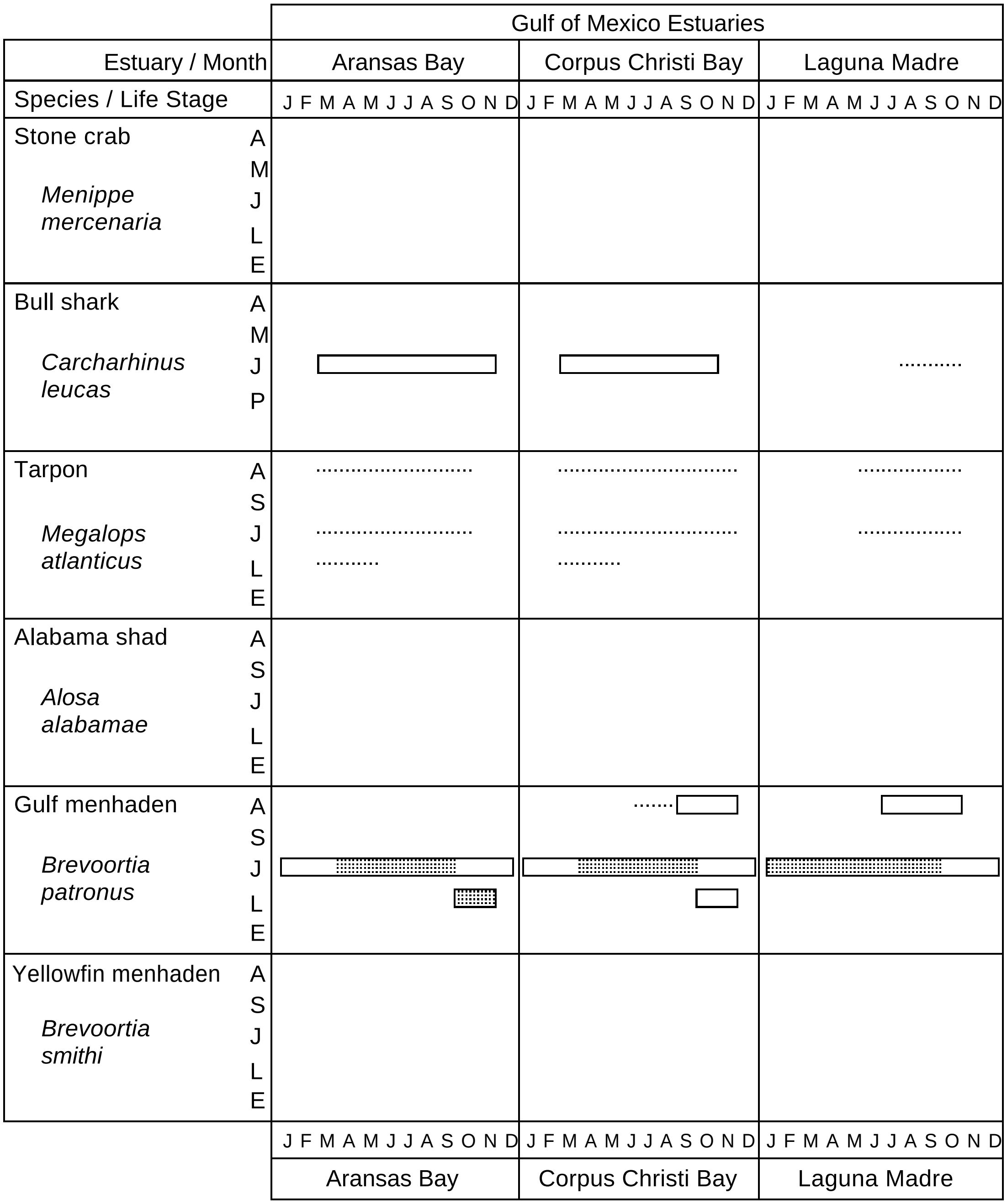
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

Blank Not Present

Life Stage

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S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating
P - Parturition

Table 5, continued. Temporal distribution

		Gulf of Mexico Estuaries											
Estuary / Month		Baffin Bay											
Species / Life Stage		J	F	M	A	M	J	J	A	S	O	N	D
Stone crab *Menippe mercenaria*	A												
	M												
	J												
	L												
	E												
Bull shark *Carcharhinus leucas*	A												
	M												
	J	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare
	P												
Tarpon *Megalops atlanticus*	A												
	S												
	J			Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	
	L												
	E												
Alabama shad *Alosa alabamae*	A												
	S												
	J												
	L												
	E												
Gulf menhaden *Brevoortia patronus*	A										Rare		
	S												
	J	Abundant	Abundant	Highly Abundant	Highly Abundant	Highly Abundant	Highly Abundant	Highly Abundant	Highly Abundant	Abundant	Abundant	Abundant	Abundant
	L		Rare	Rare	Rare	Rare							
	E												
Yellowfin menhaden *Brevoortia smithi*	A												
	S												
	J												
	L												
	E												
		J	F	M	A	M	J	J	A	S	O	N	D
		Baffin Bay											

Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank — Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
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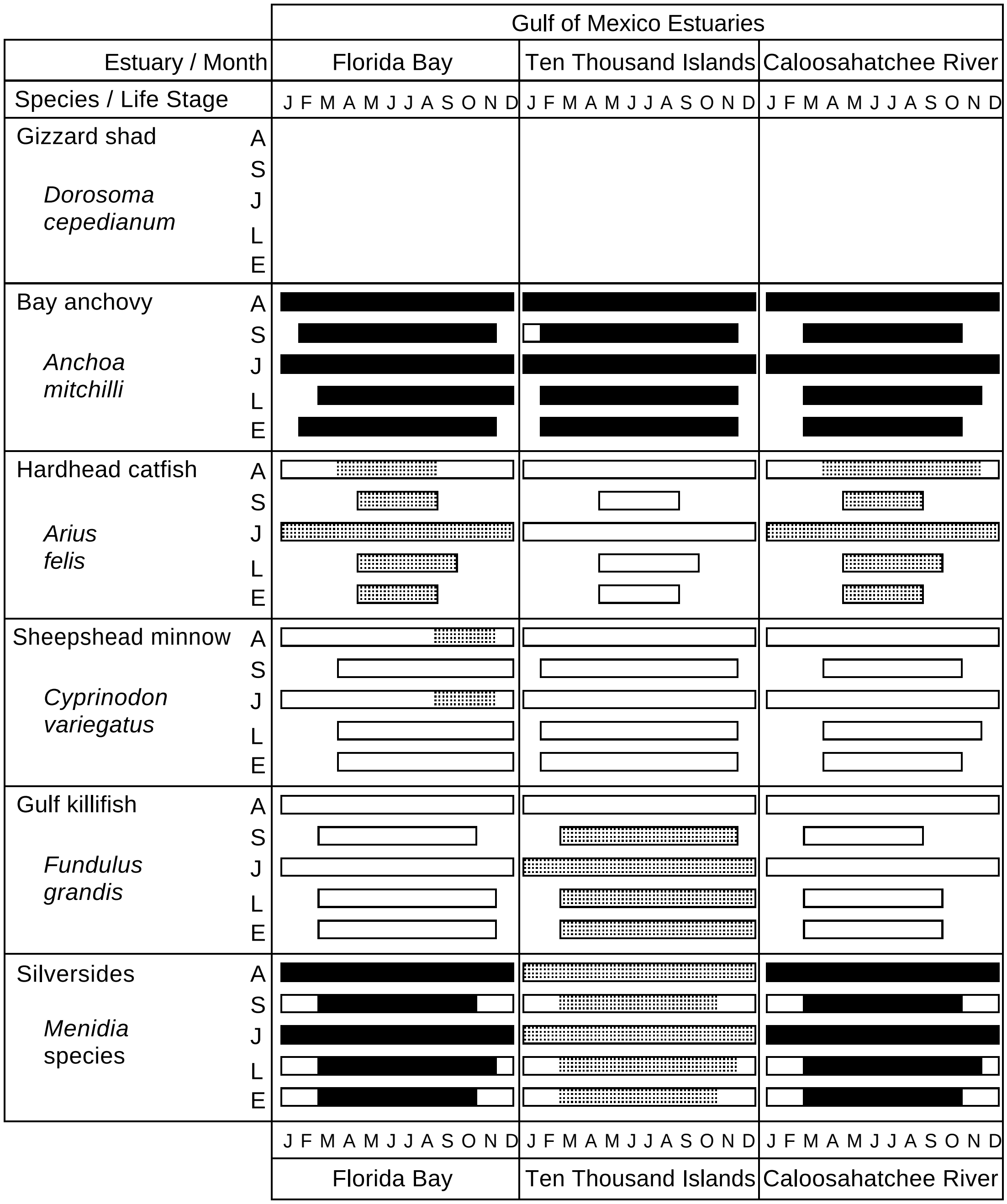
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

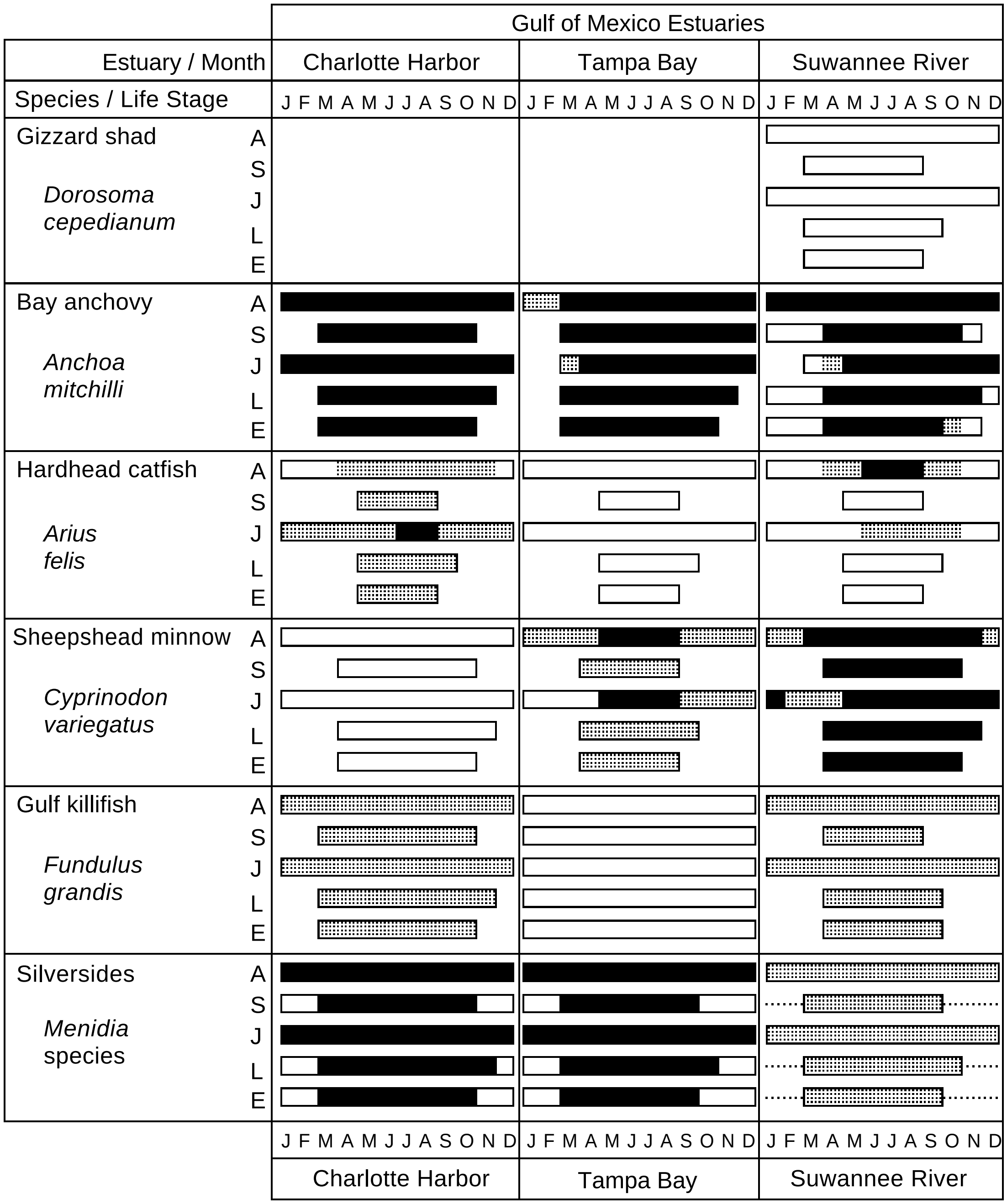
.... Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

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Blank Not Present

Life Stage

A - Adults
S - Spawning adults
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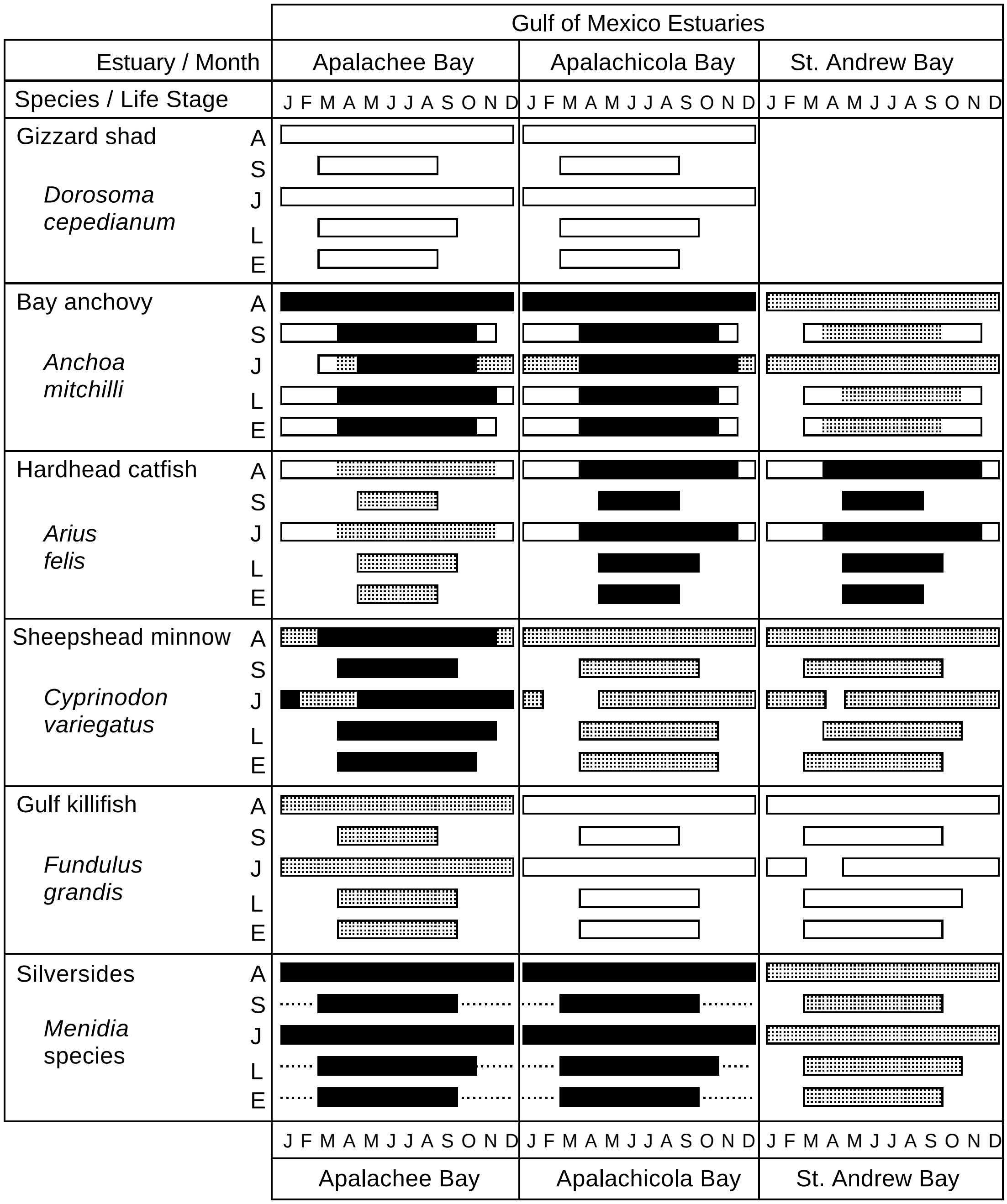
E - Eggs

Table 5, continued. Temporal distribution



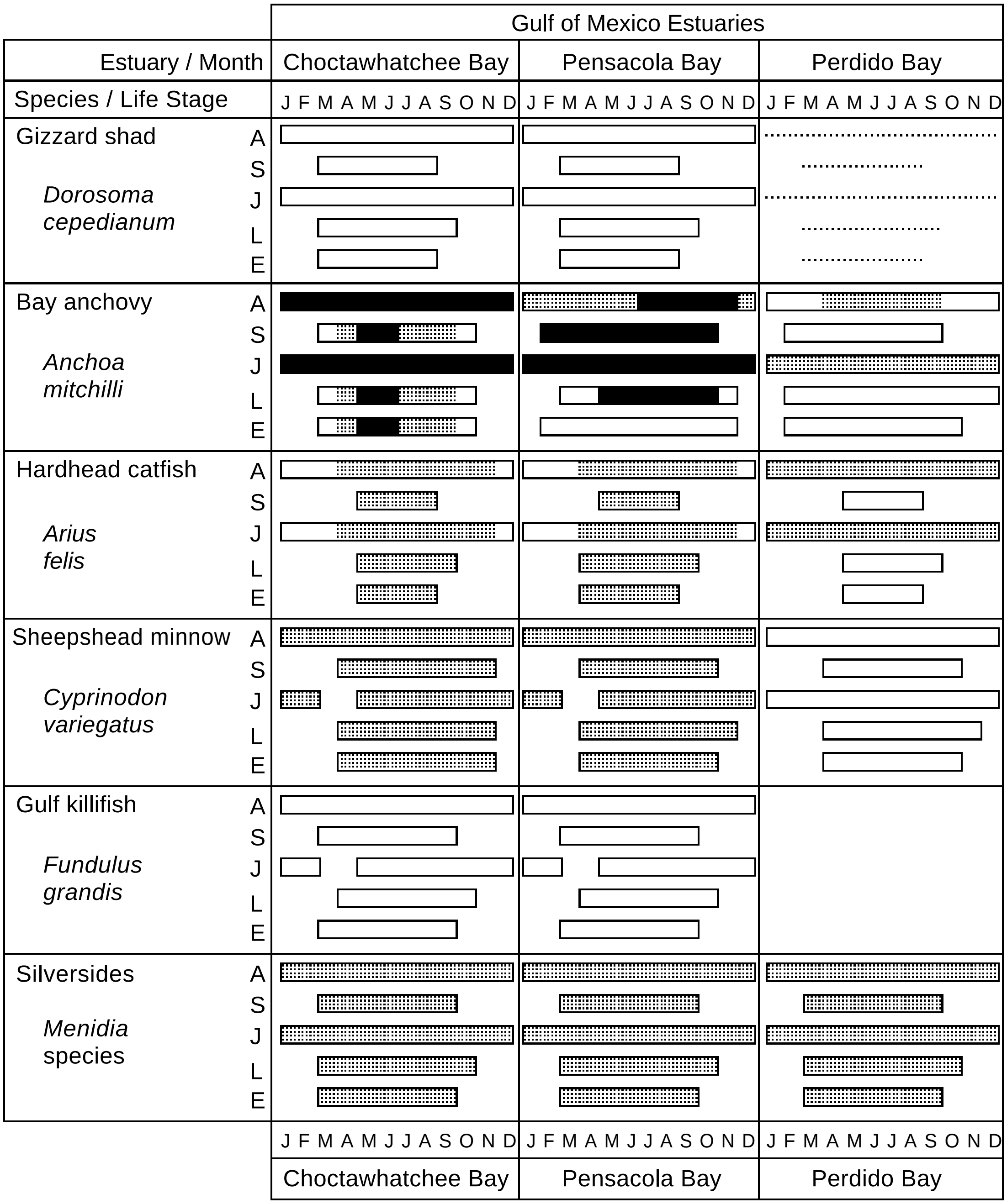
Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank — Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant
Abundant
Common
.... Rare
Blank Not Present

Life Stage

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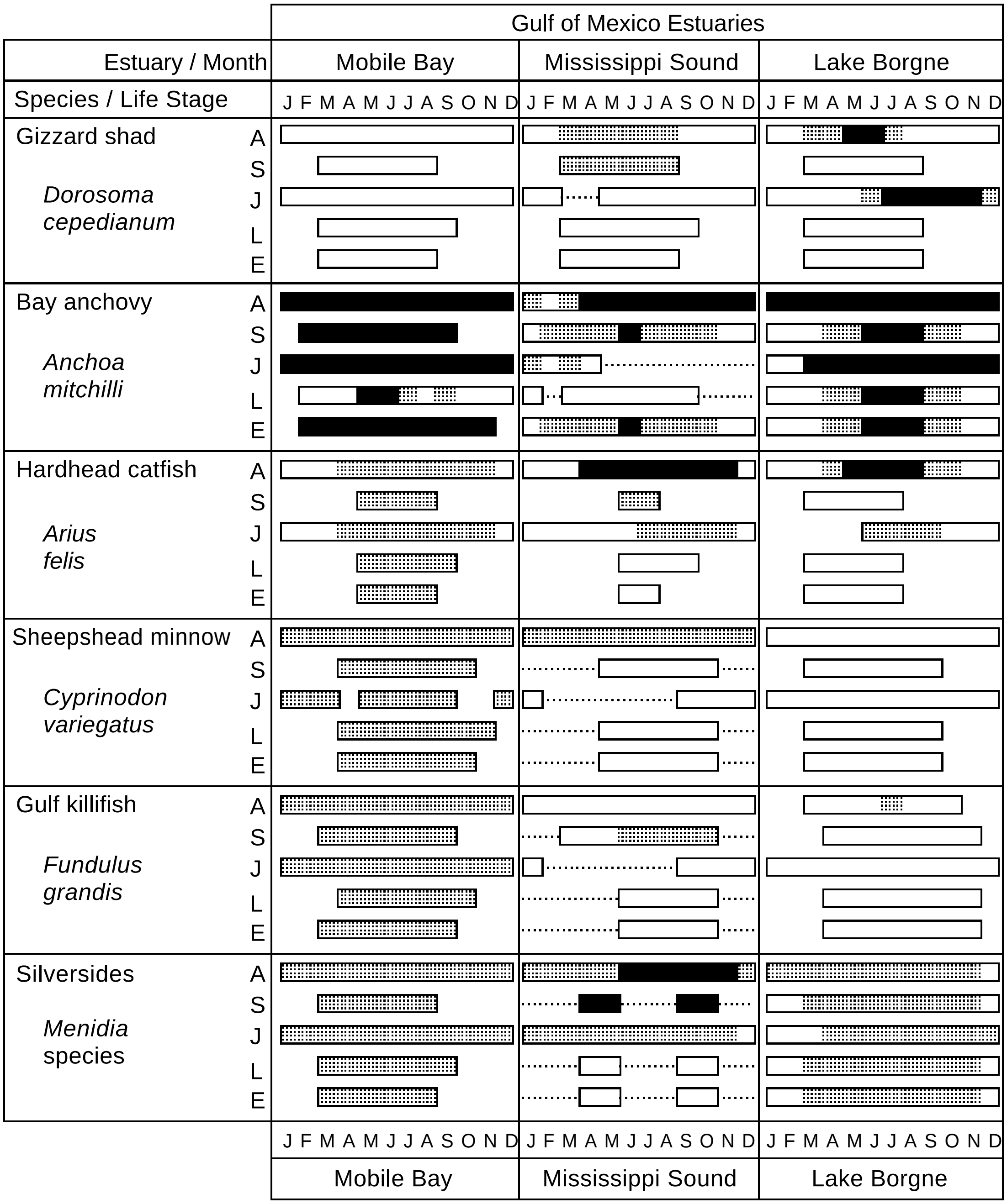
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant
Abundant
Common
Rare
Blank Not Present

Life Stage

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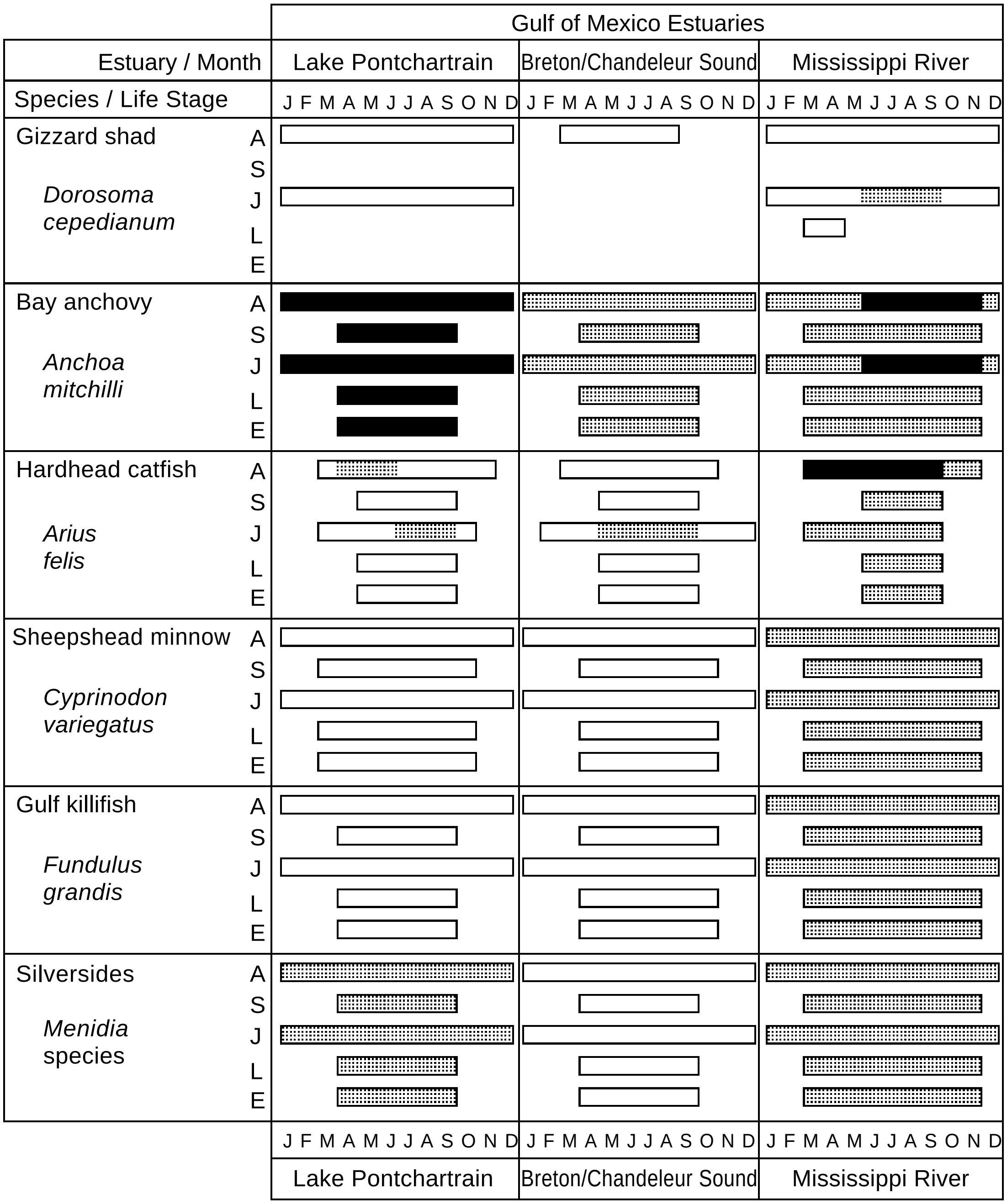
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

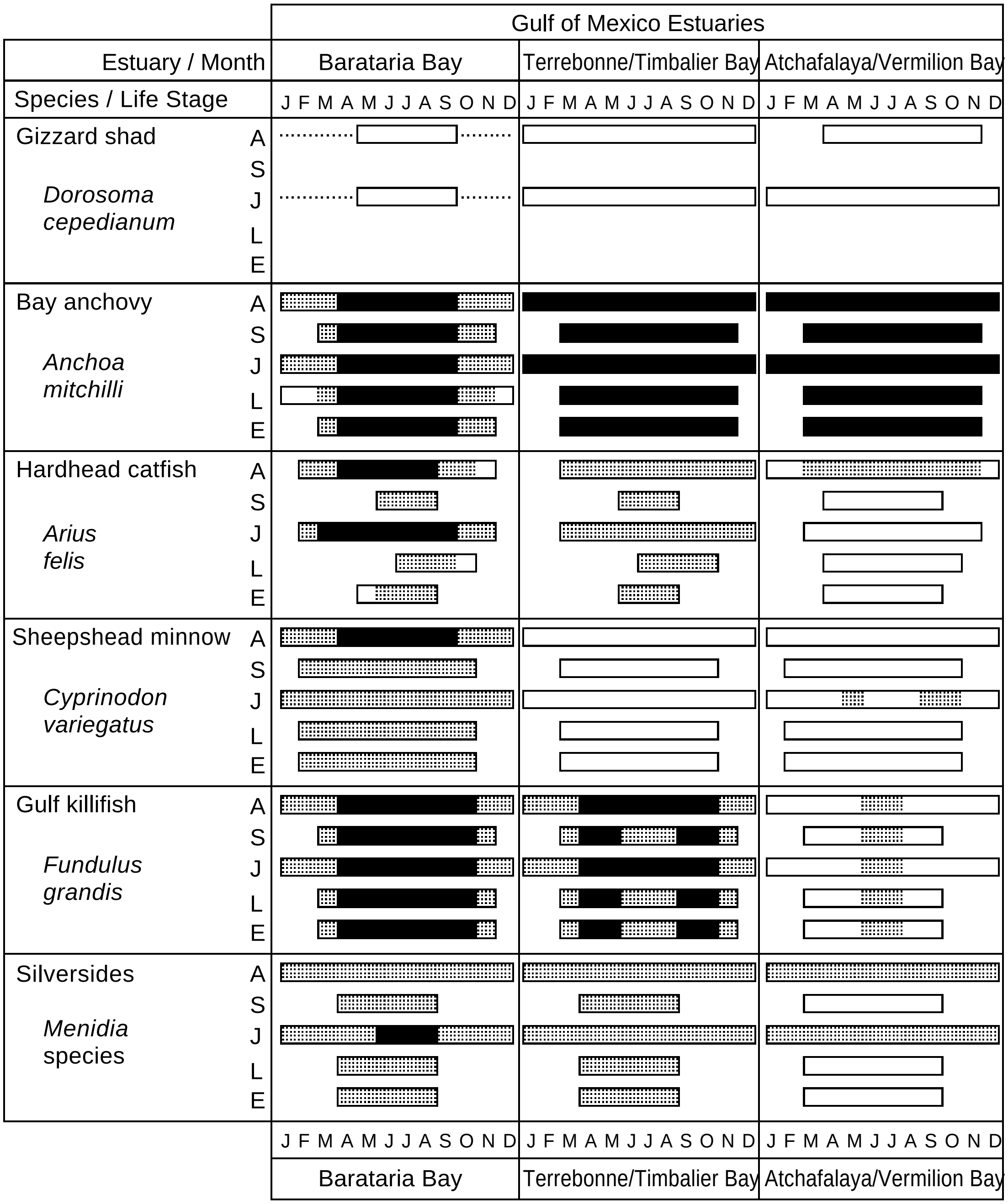
.... Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

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- ·········· Rare
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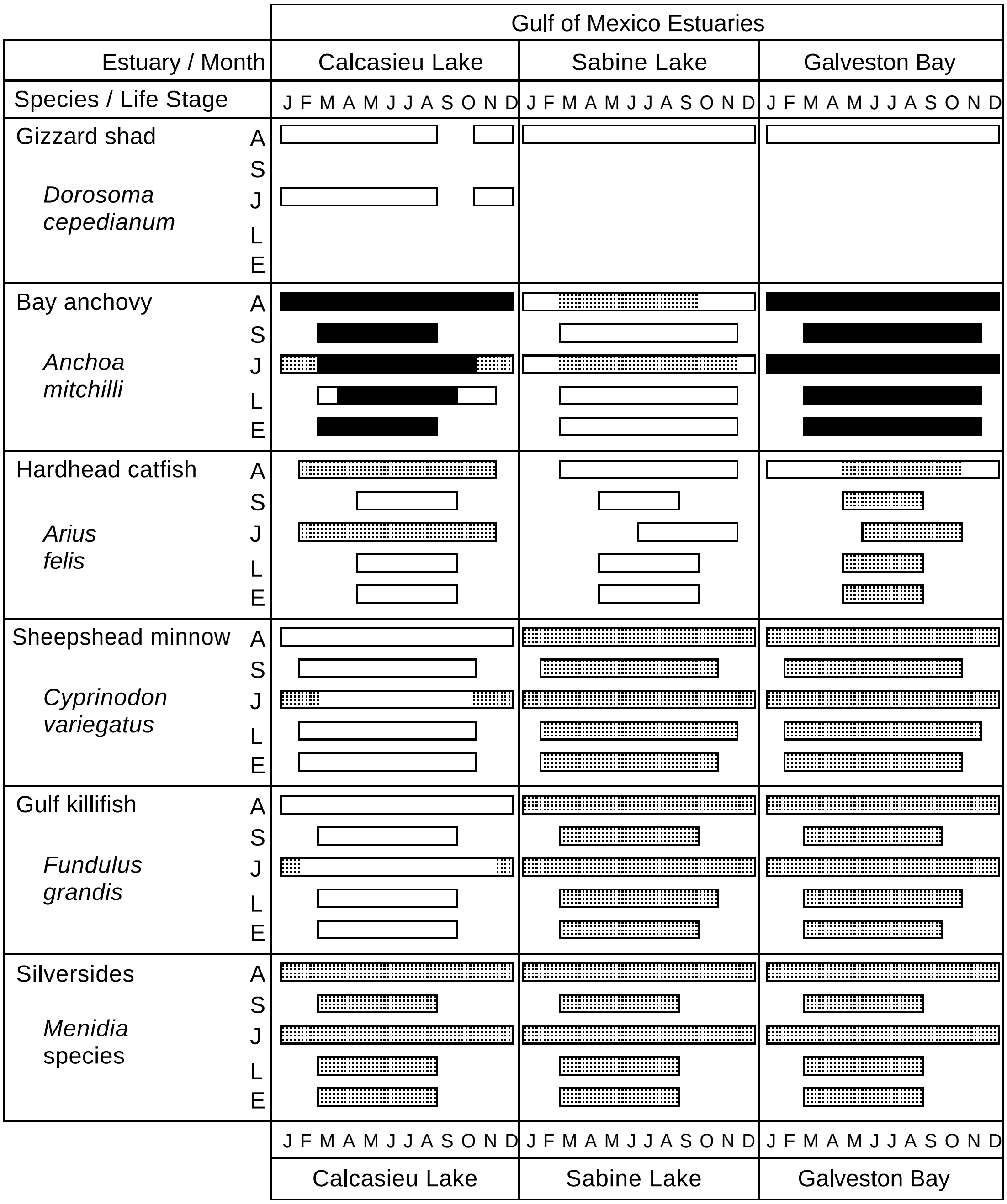
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

.... Rare

Blank Not Present

Life Stage

A - Adults
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J - Juveniles
L - Larvae
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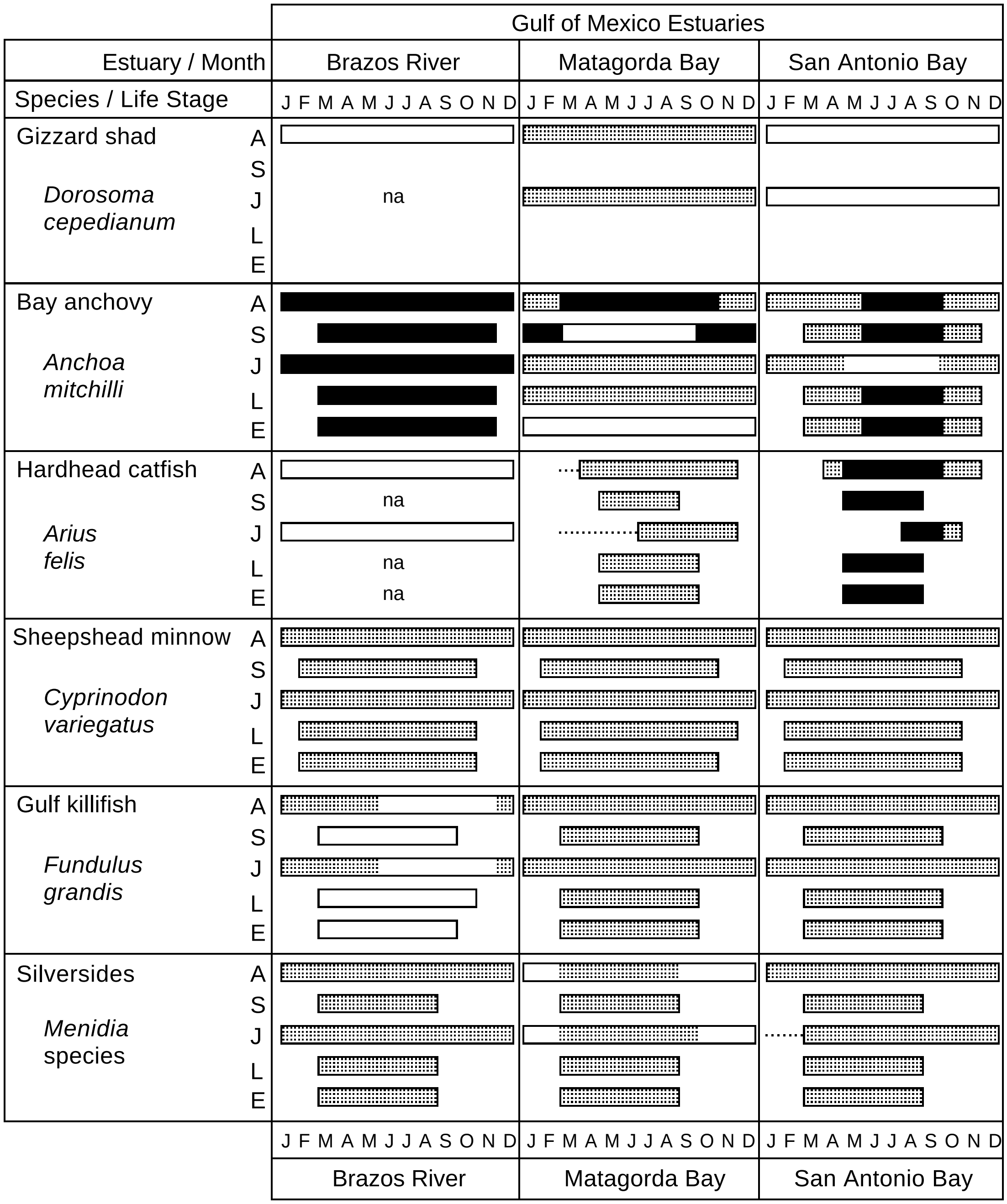
Table 5, continued. Temporal distribution



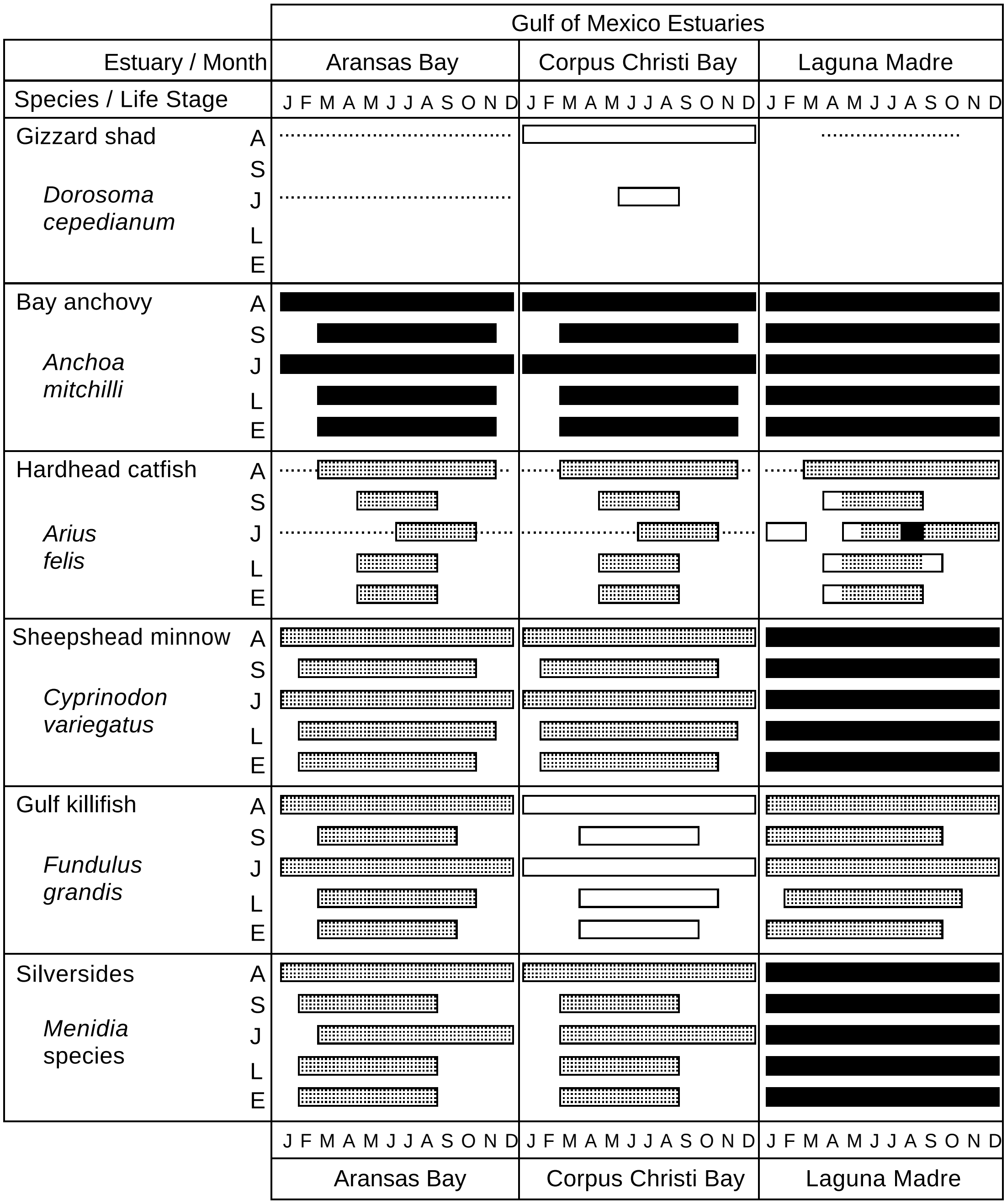
Relative Abundance

Highly Abundant
Abundant
Common
Rare
Blank Not Present
n No Data Available

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

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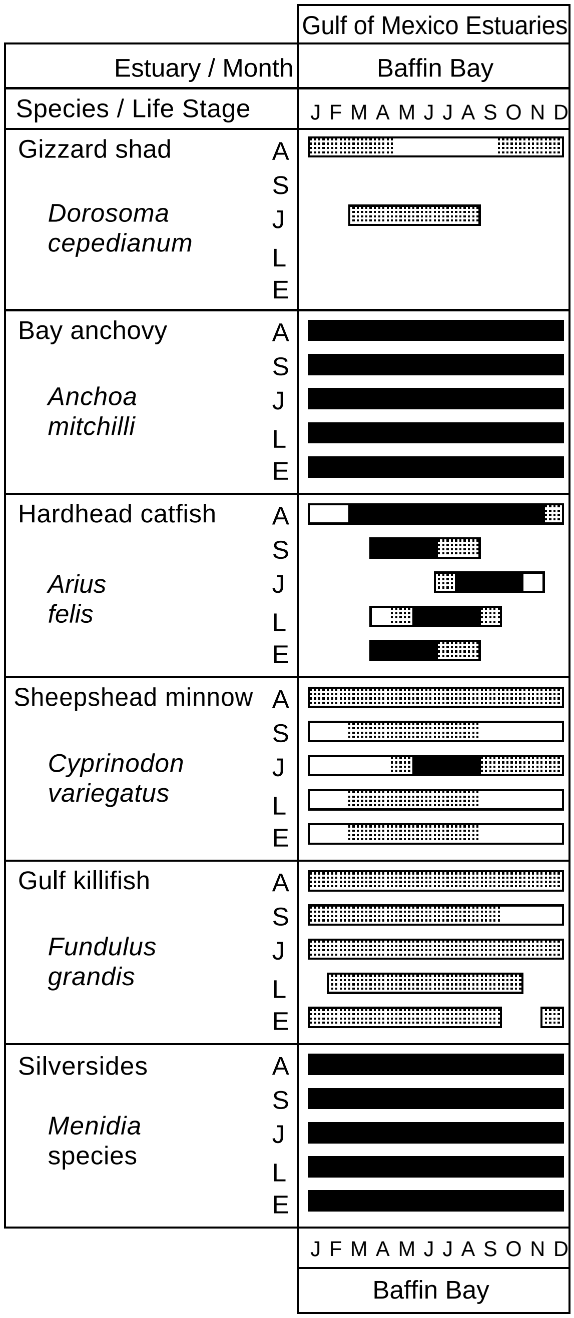
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant
Abundant
Common
Rare
Blank   Not Present

Life Stage

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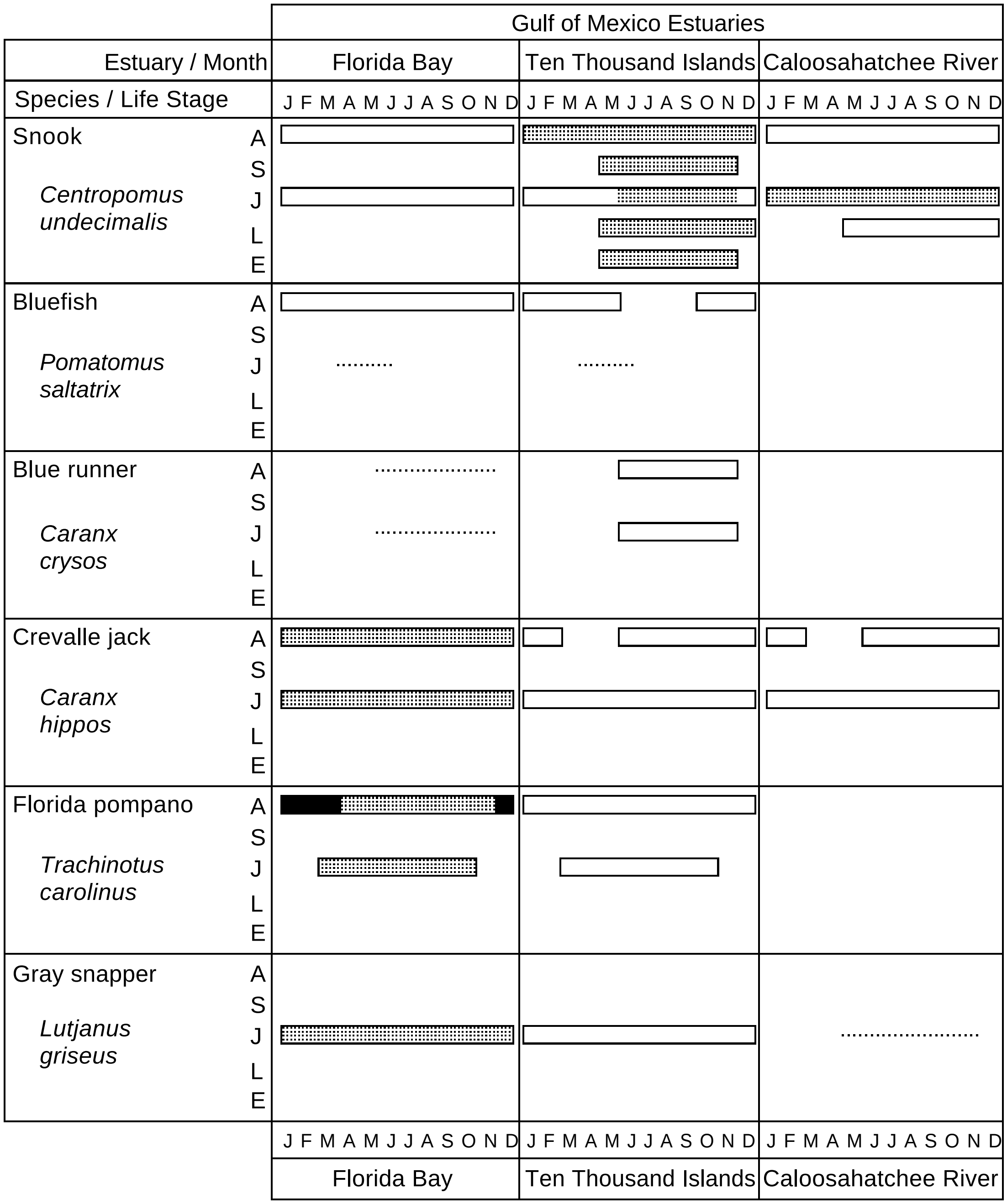
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

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Life Stage

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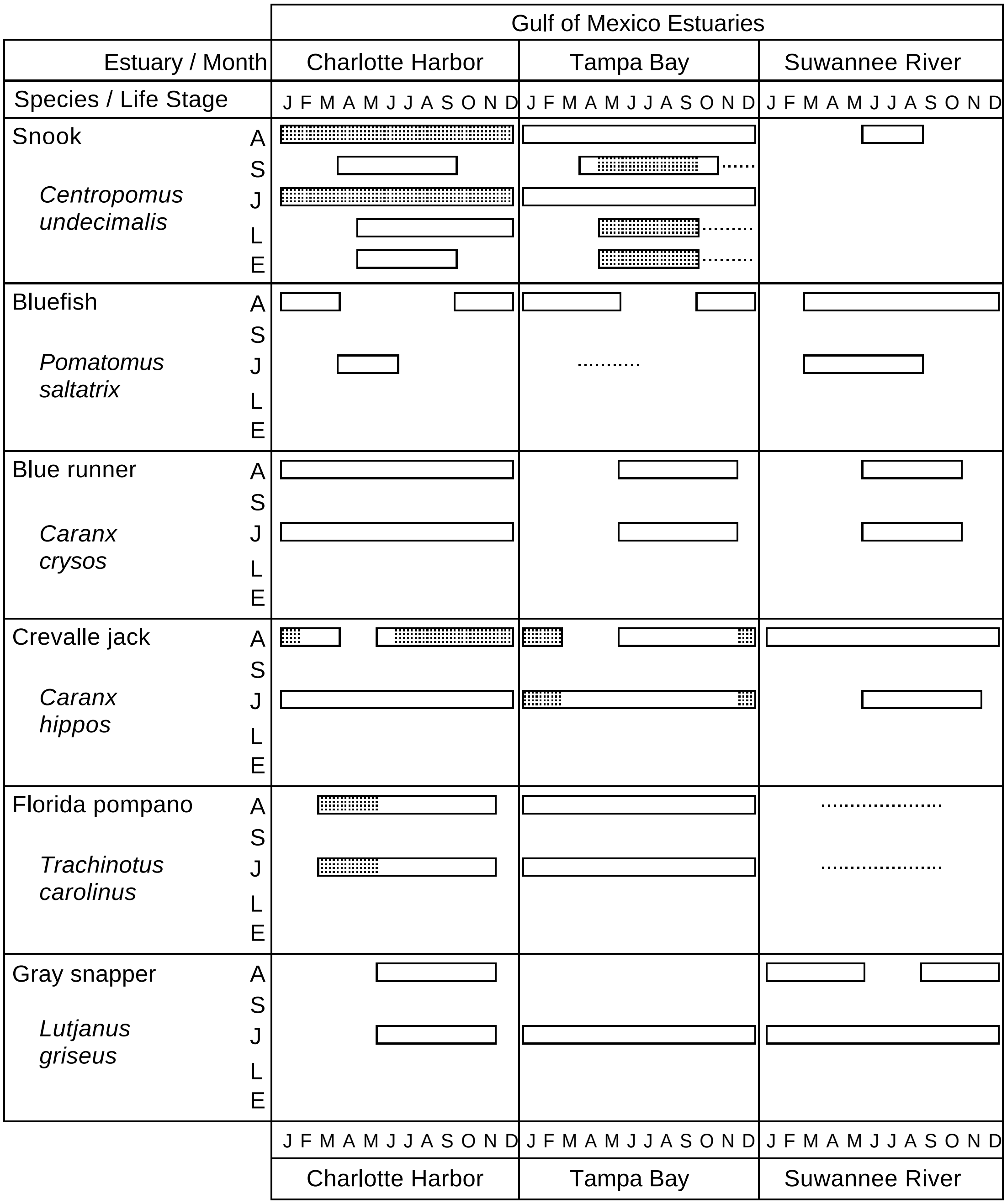
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

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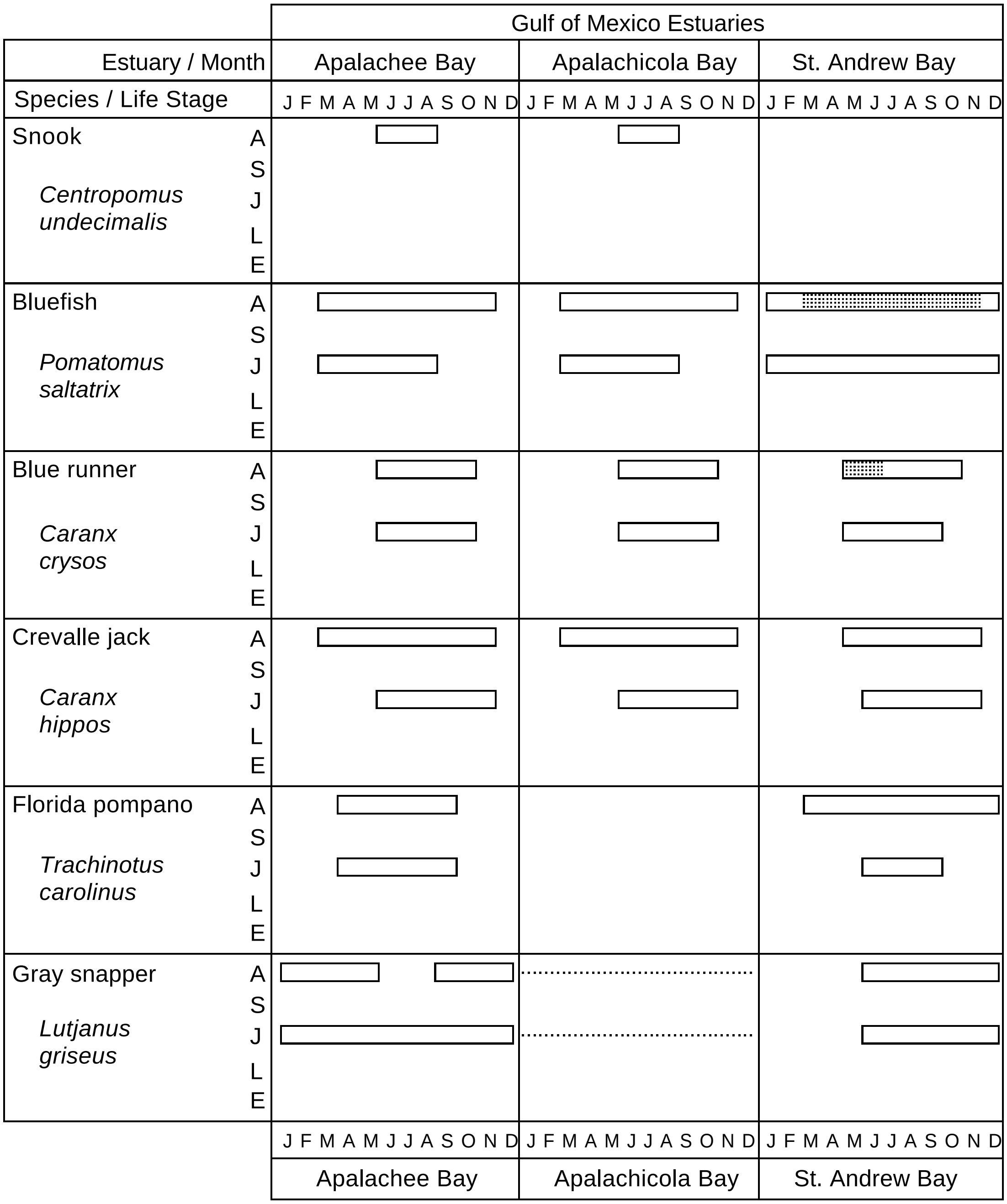
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

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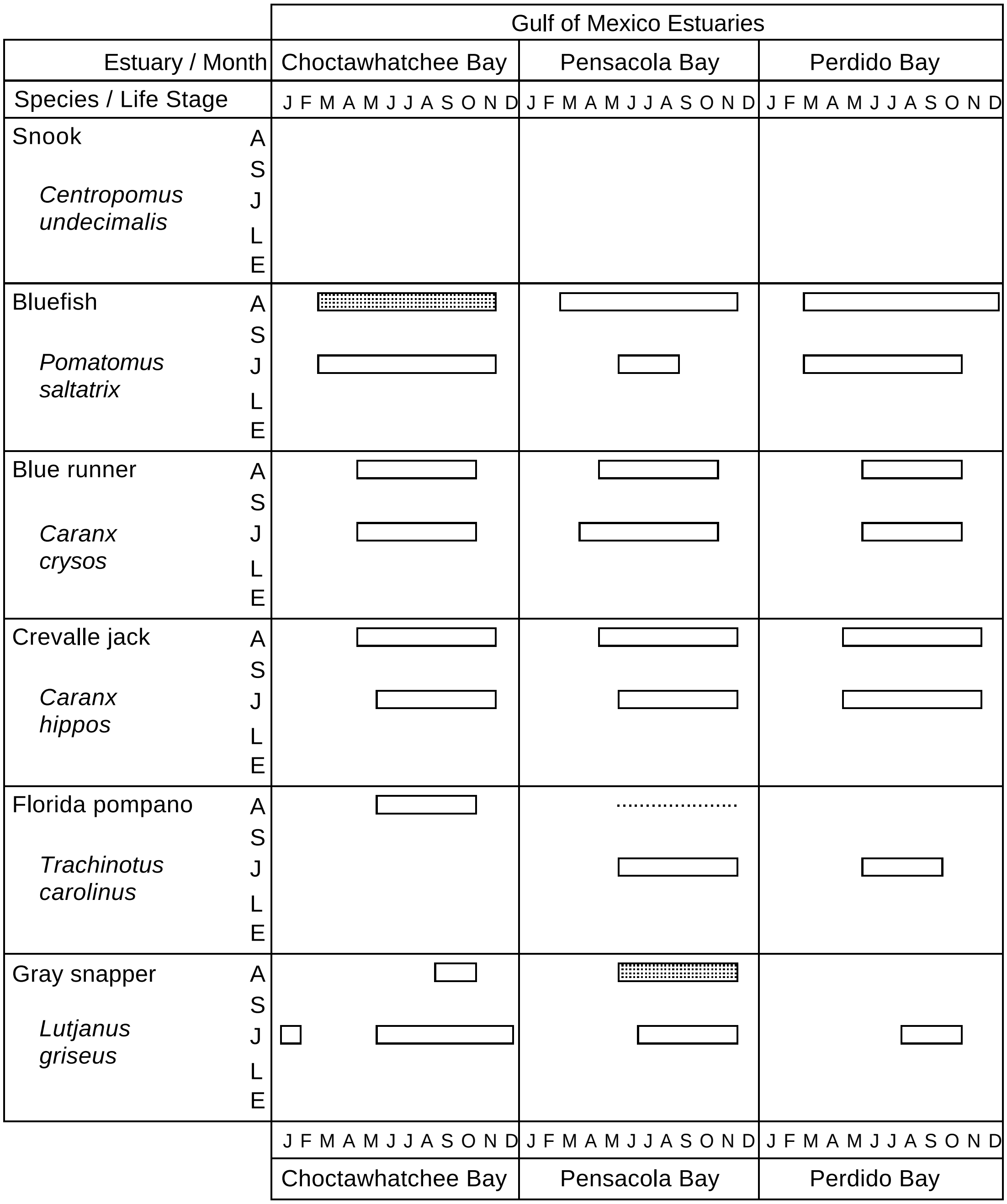
Table 5, continued. Temporal distribution



Relative Abundance

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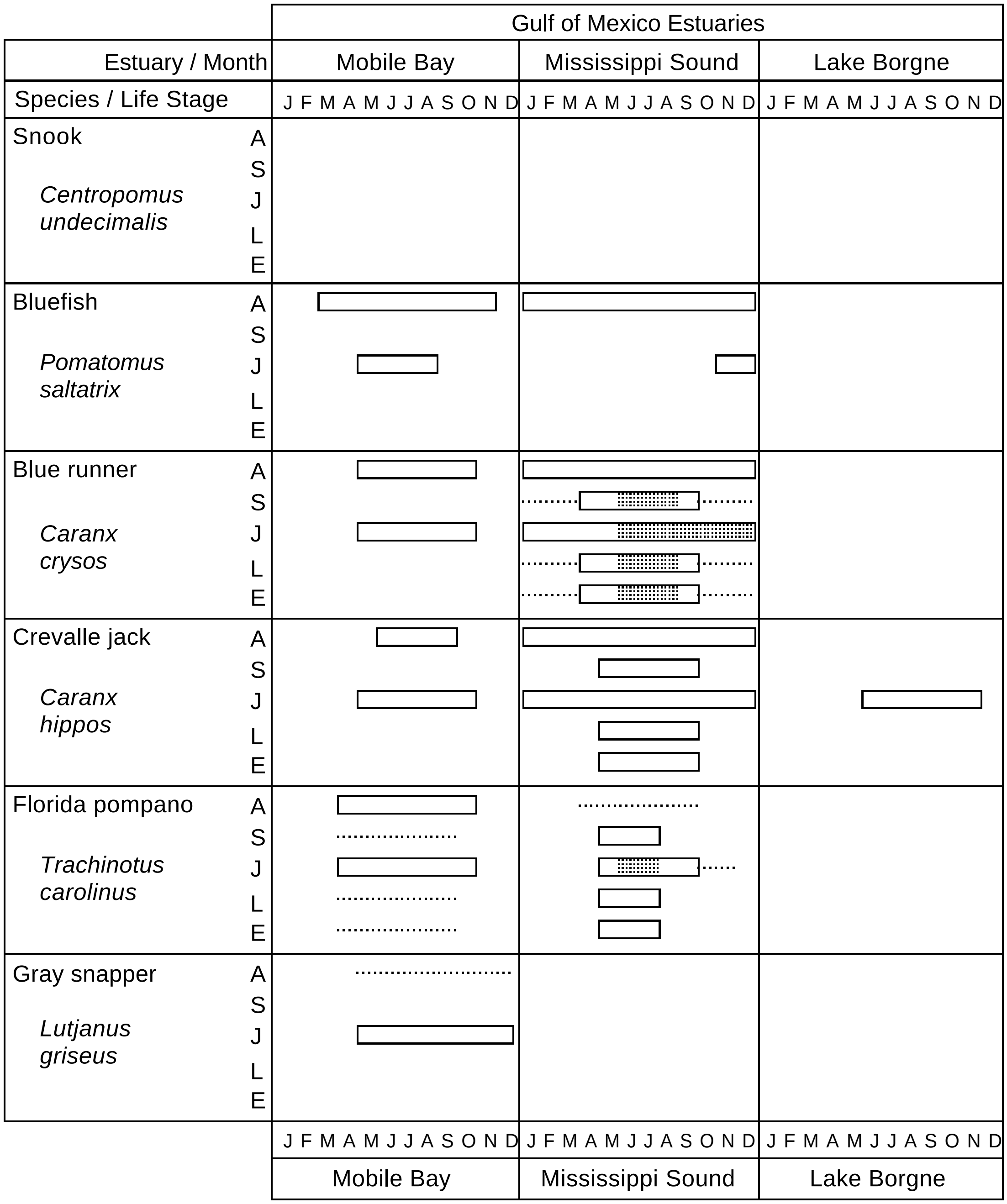
Table 5, continued. Temporal distribution



Relative Abundance

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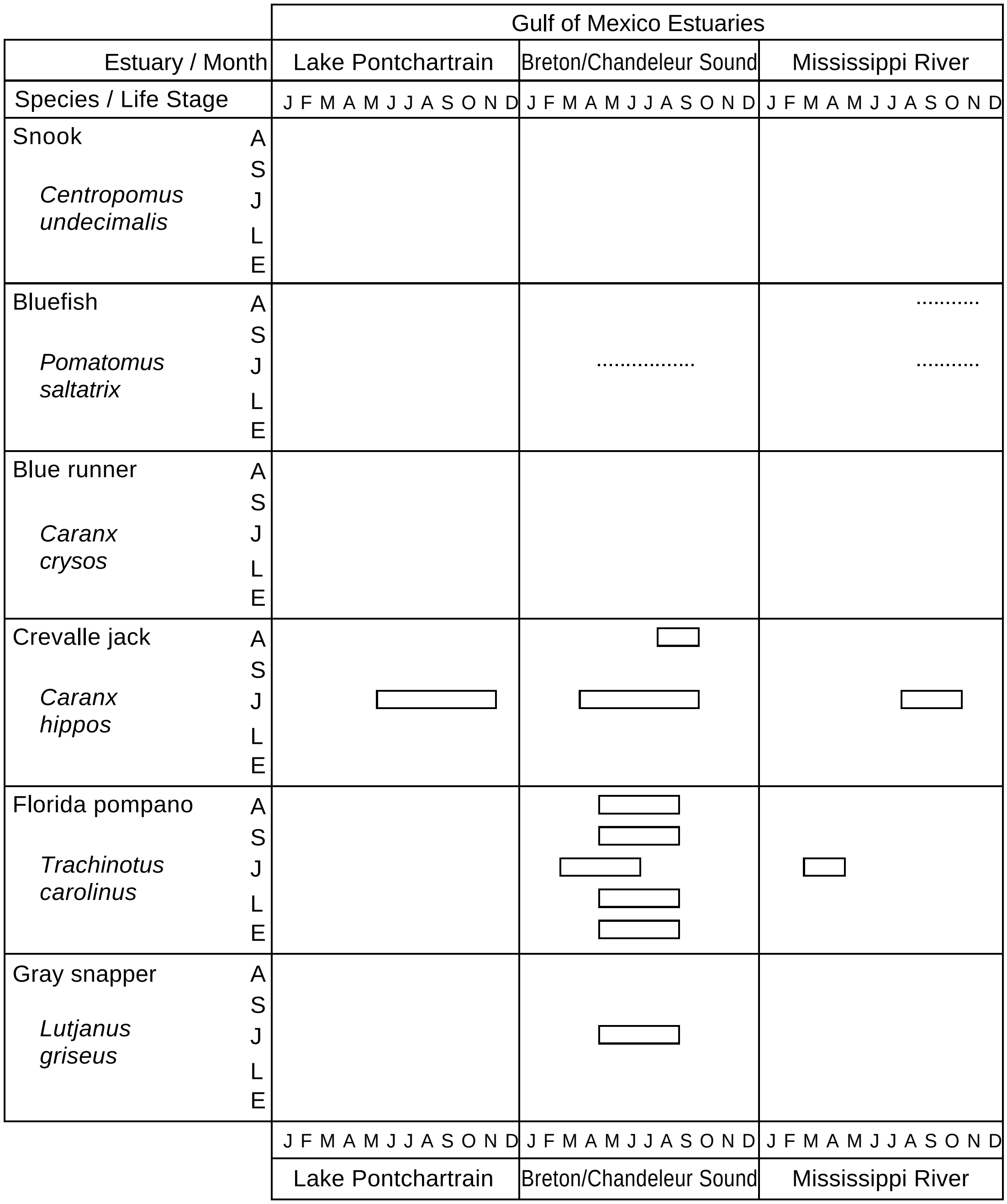
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

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Life Stage

A - Adults
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Table 5, continued. Temporal distribution

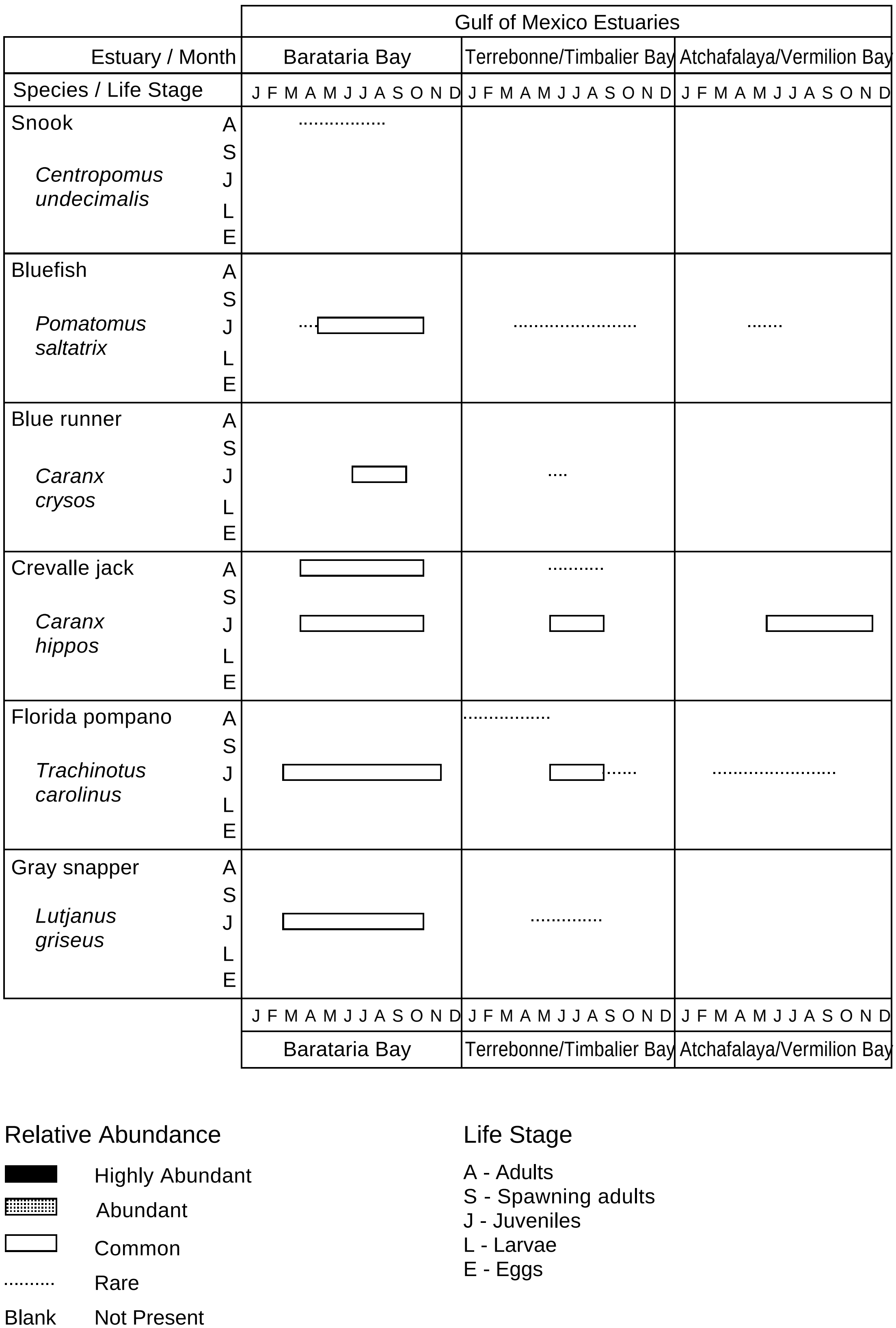
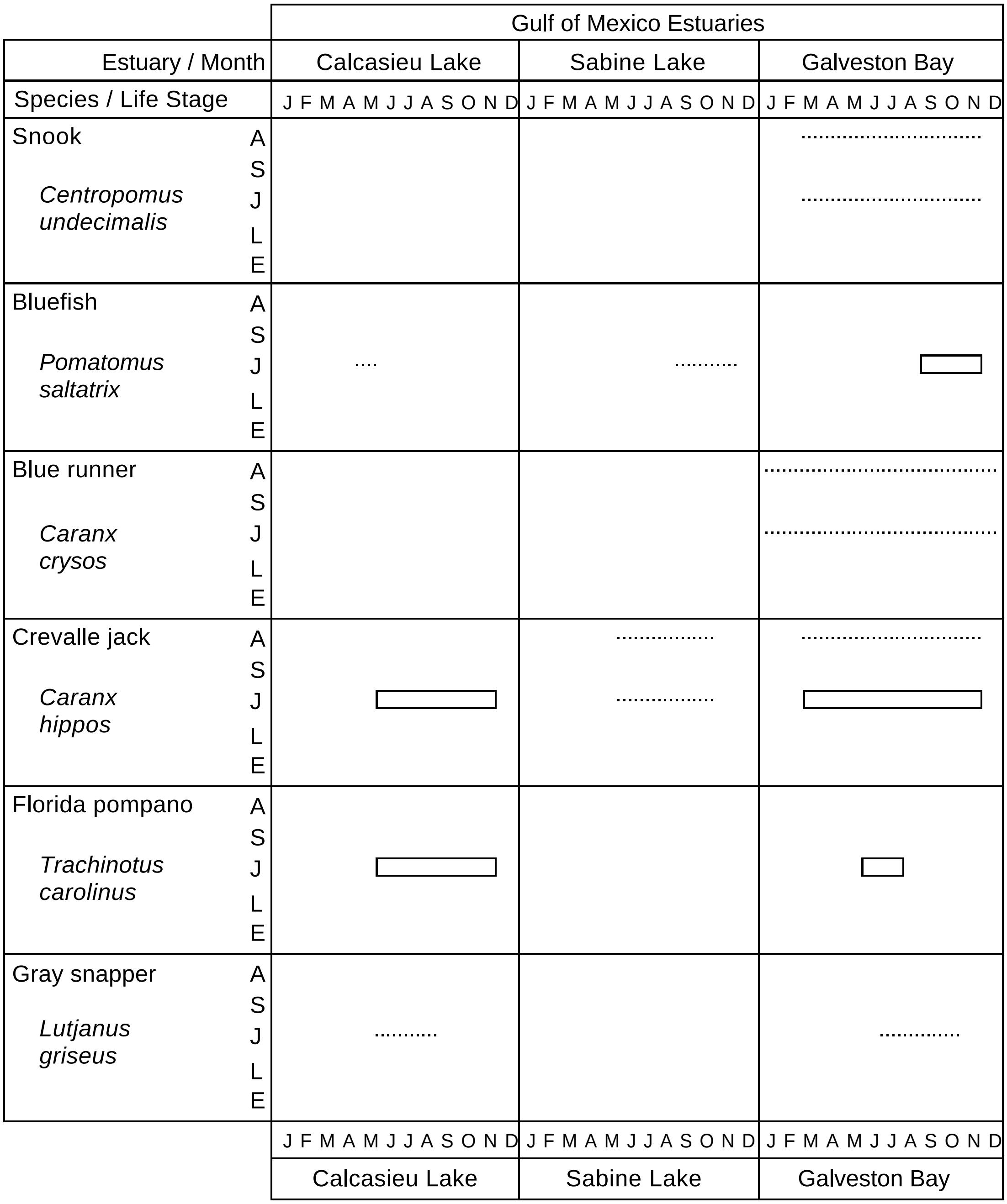


Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

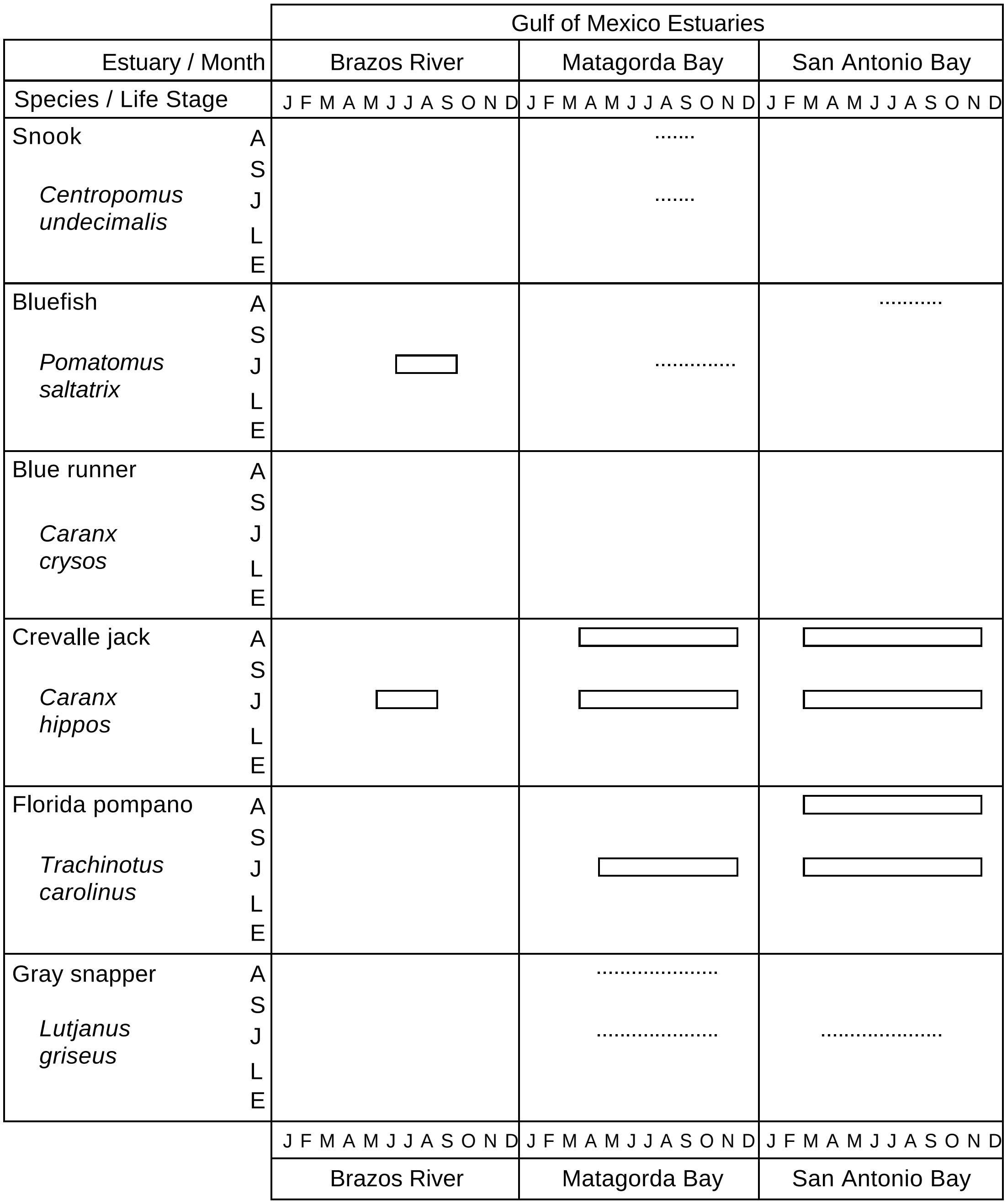
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
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Life Stage

A - Adults
S - Spawning adults
J - Juveniles
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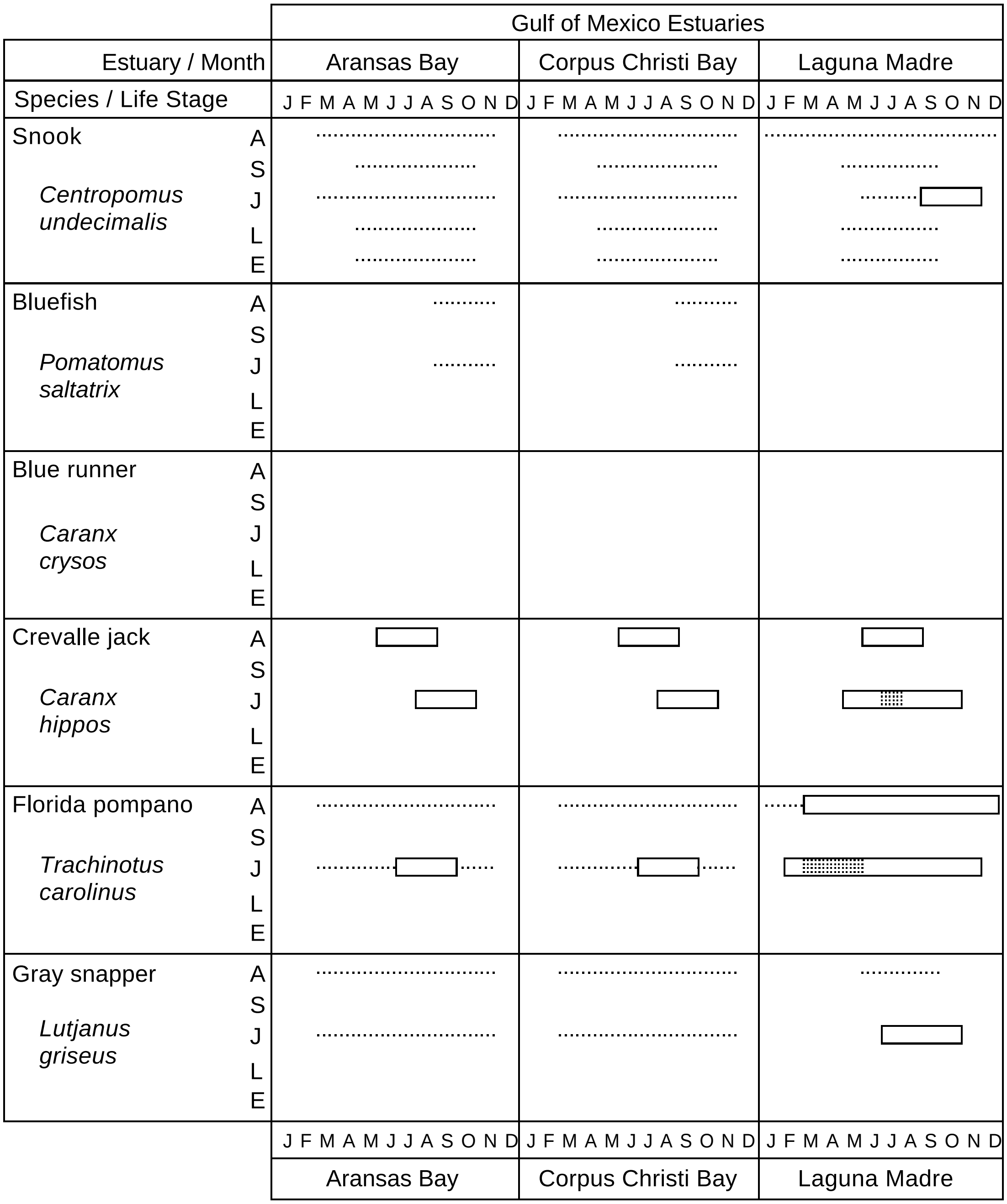
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution

		Gulf of Mexico Estuaries											
Estuary / Month		Baffin Bay											
Species / Life Stage		J	F	M	A	M	J	J	A	S	O	N	D
Snook *Centropomus undecimalis*	A												
	S												
	J												
	L												
	E												
Bluefish *Pomatomus saltatrix*	A												
	S												
	J												
	L												
	E												
Blue runner *Caranx crysos*	A												
	S												
	J												
	L												
	E												
Crevalle jack *Caranx hippos*	A					Common	Common	Common	Common	Common			
	S												
	J					Common	Common	Common	Common	Common	Common		
	L												
	E												
Florida pompano *Trachinotus carolinus*	A	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare
	S												
	J			Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	
	L												
	E												
Gray snapper *Lutjanus griseus*	A	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare
	S												
	J	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare
	L												
	E												
		J	F	M	A	M	J	J	A	S	O	N	D
		Baffin Bay											

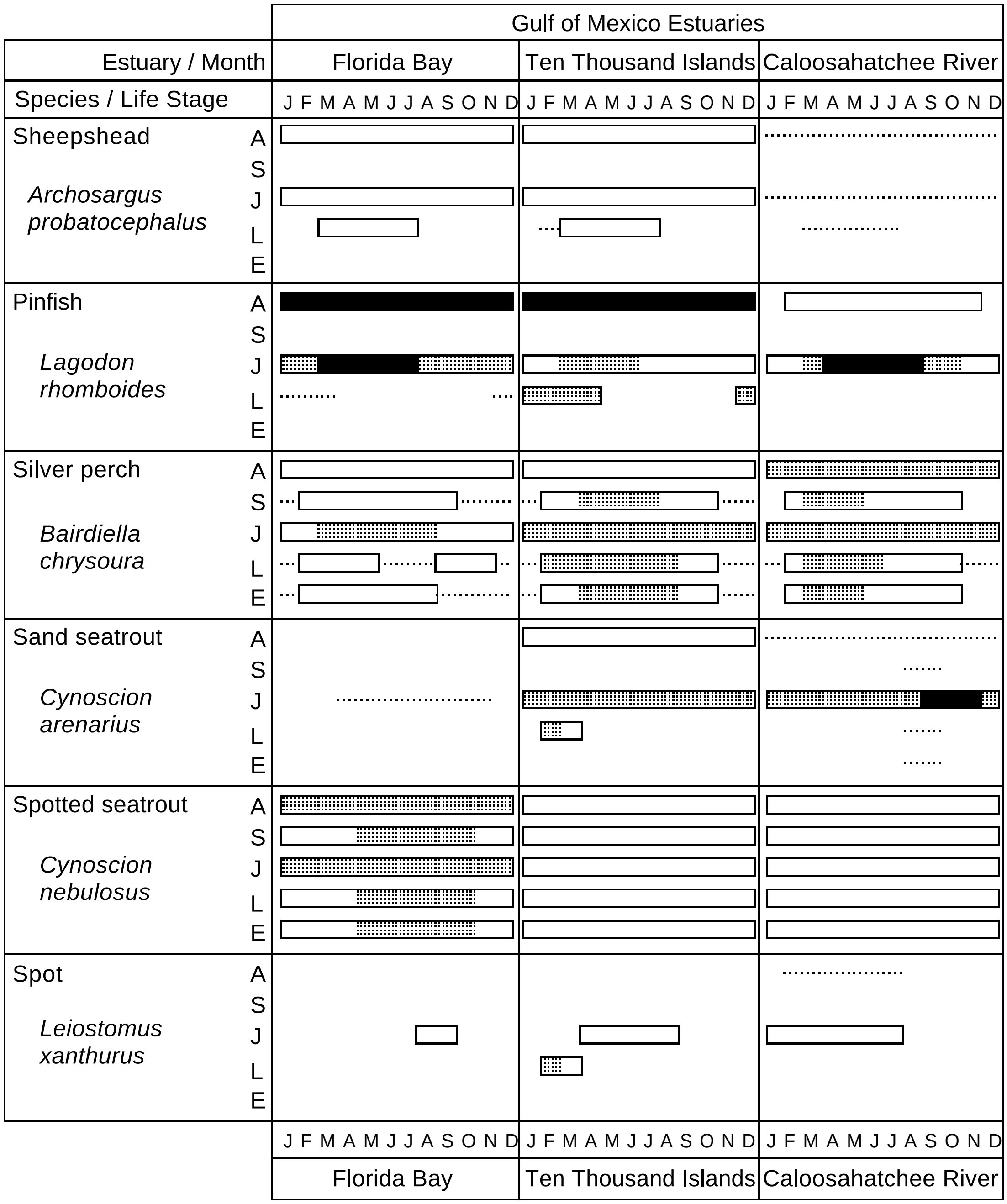
Relative Abundance

- (solid black bar) Highly Abundant
- (stippled bar) Abundant
- (open bar) Common
- .... Rare
- Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

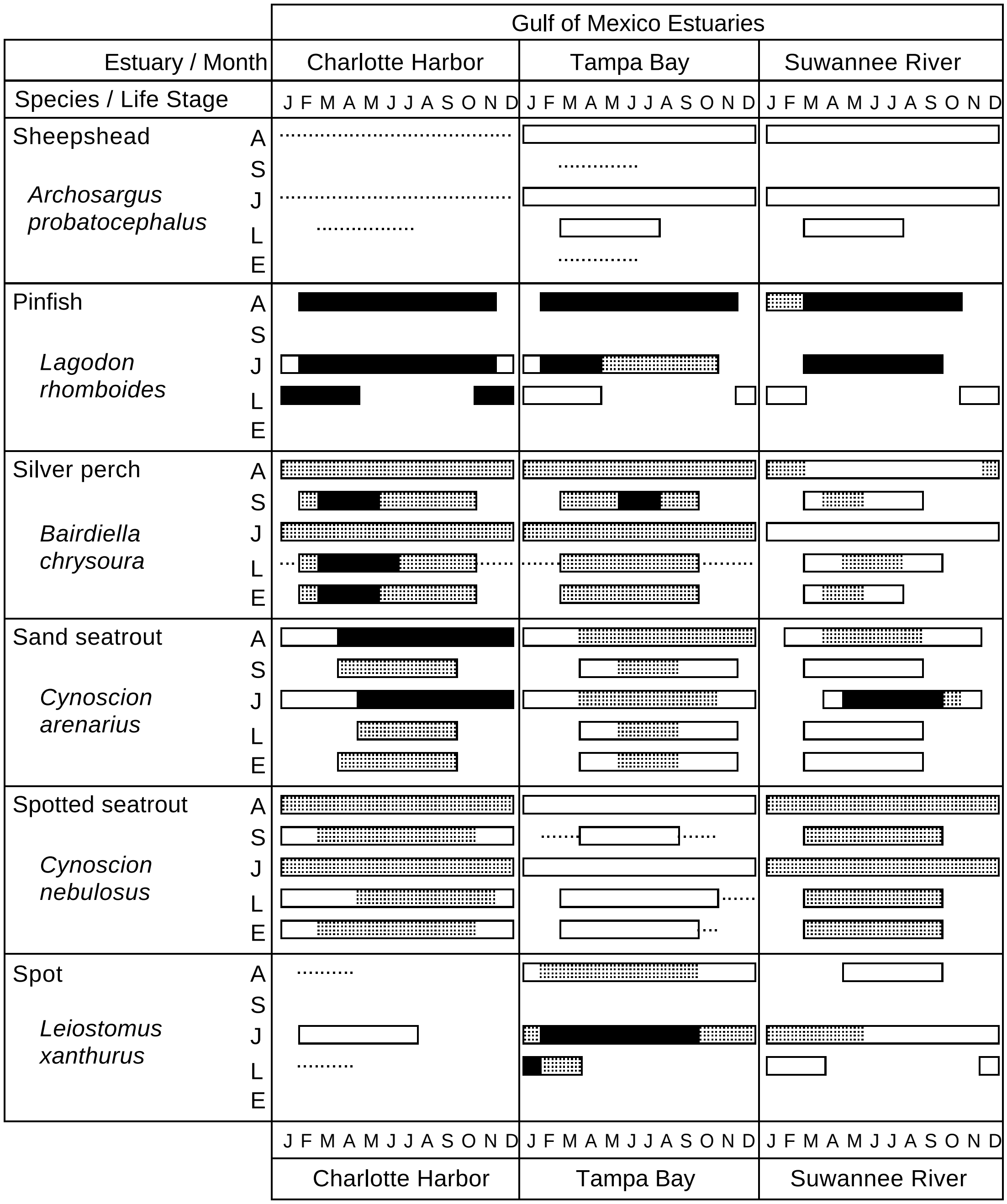
Rare

Blank   Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

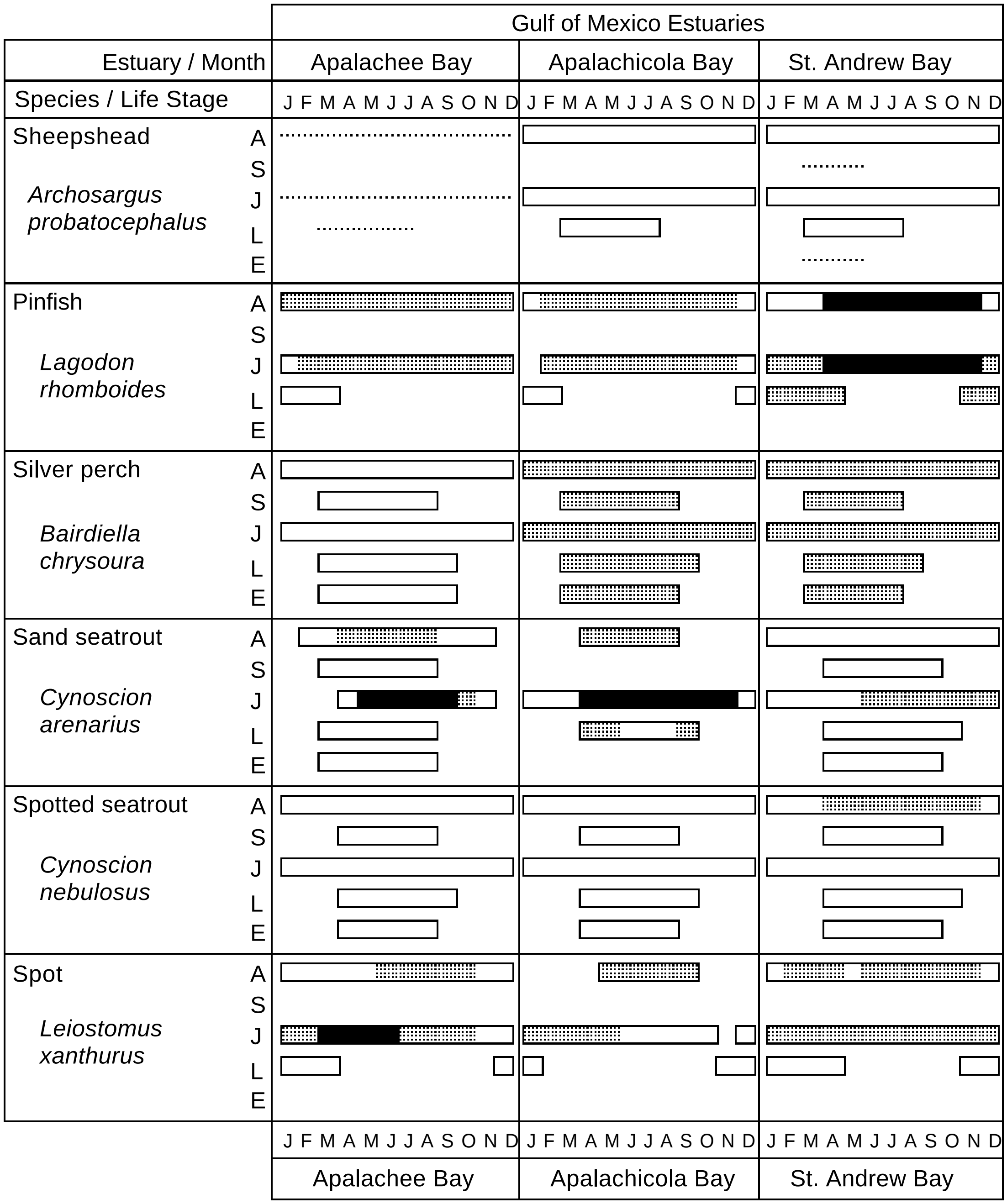
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

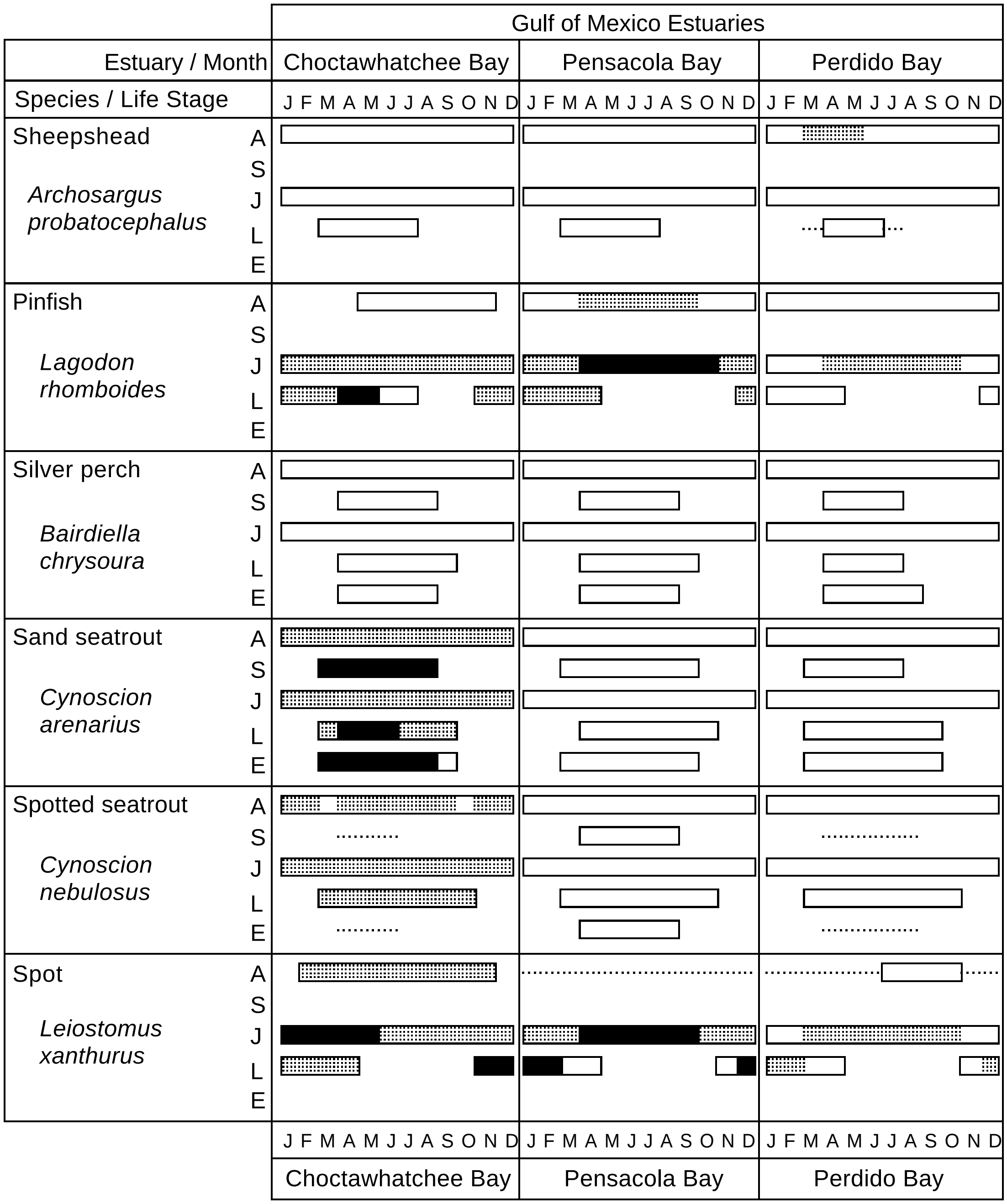
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

Blank Not Present

Life Stage

A - Adults
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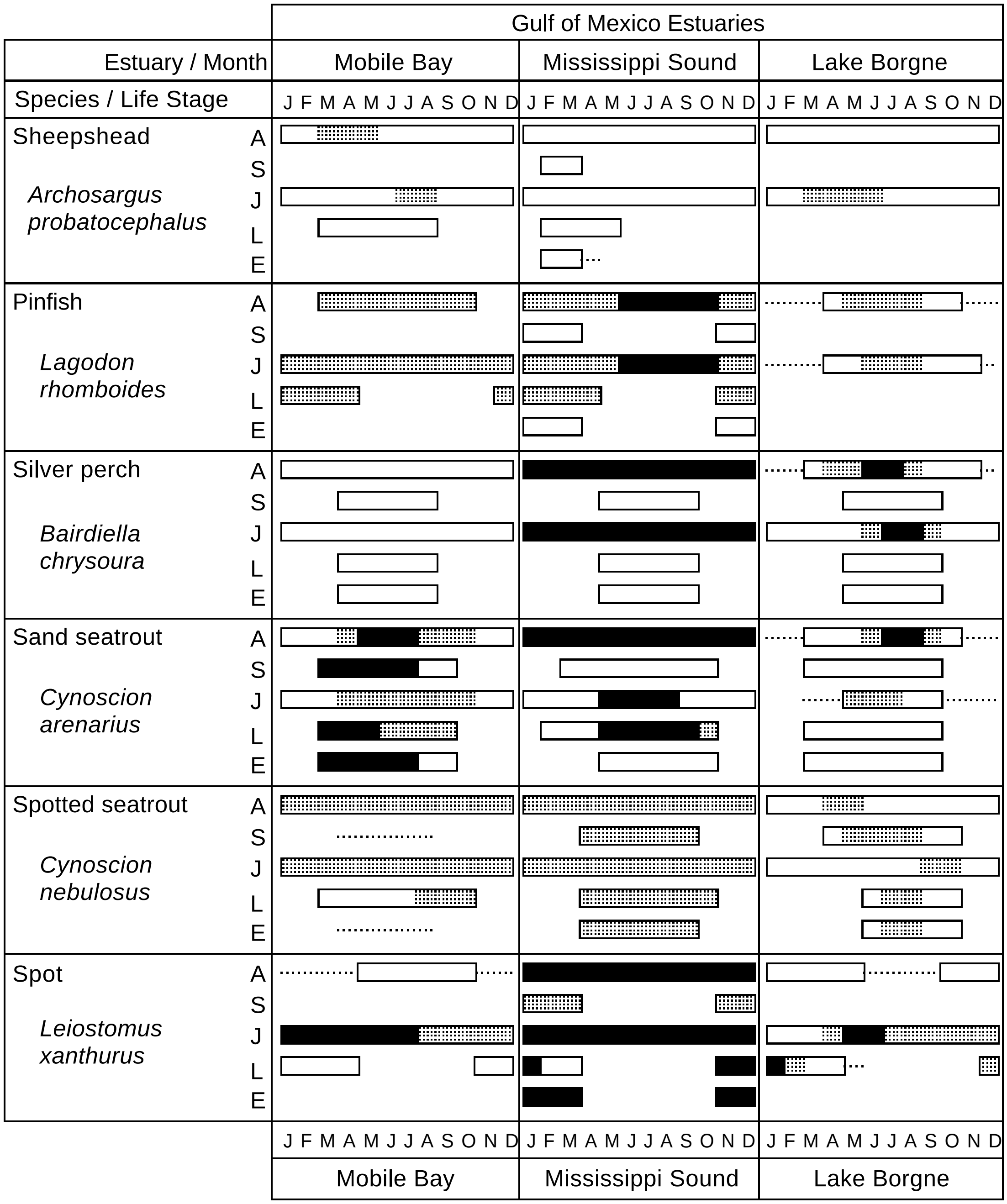
Table 5, continued. Temporal distribution



Relative Abundance

- Highly Abundant
- Abundant
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- Rare
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Life Stage

A - Adults
S - Spawning adults
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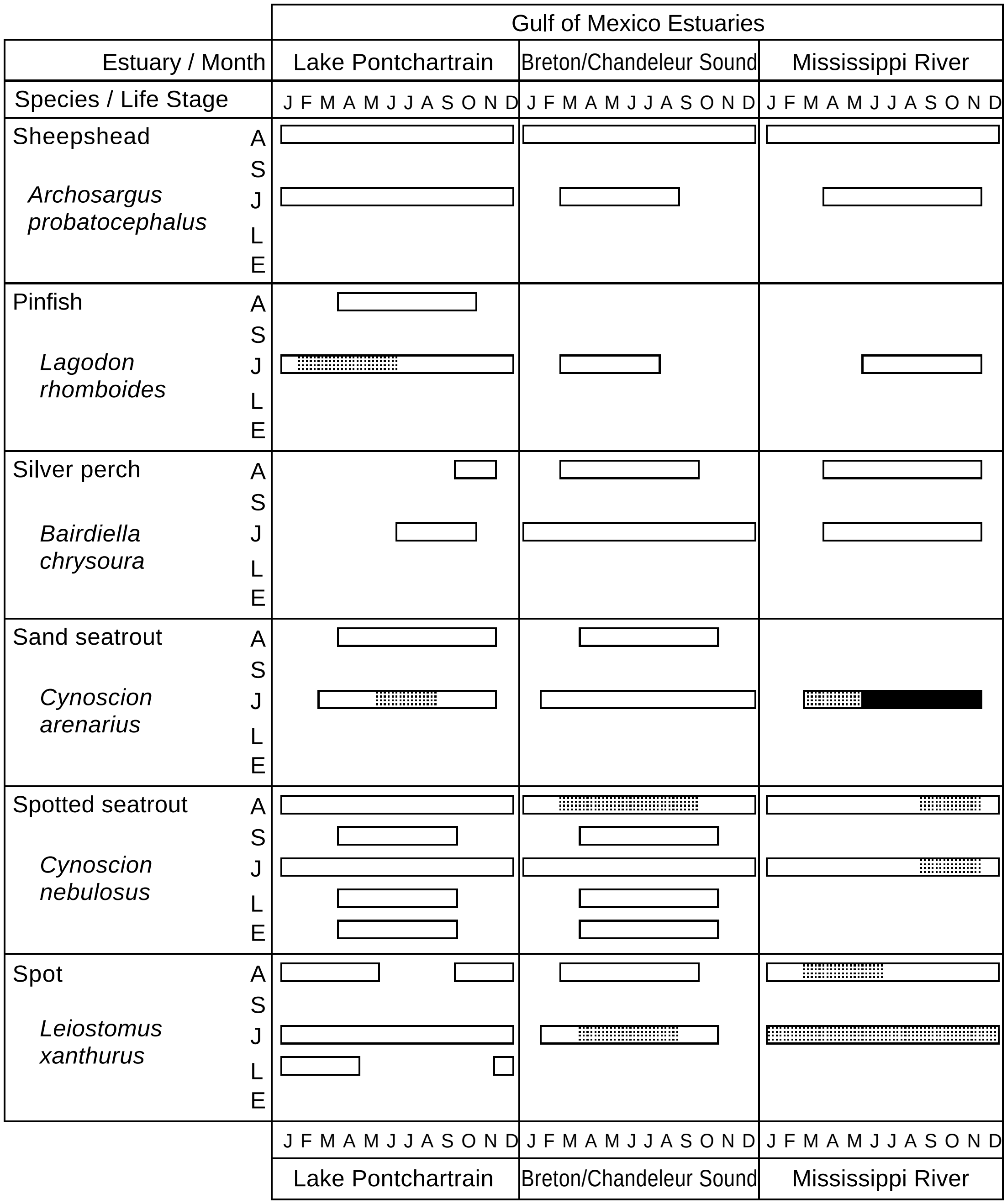
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

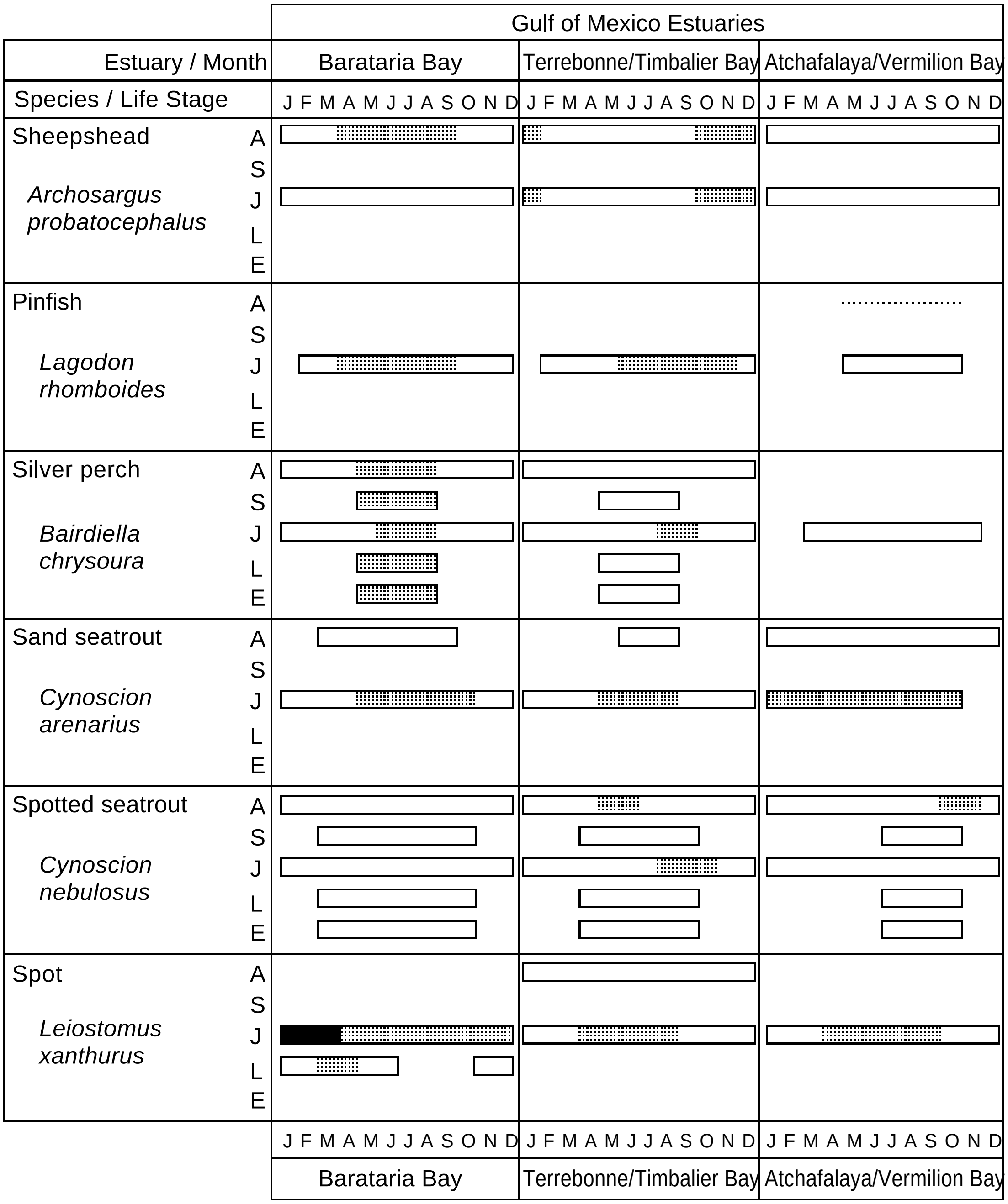
Rare

Blank Not Present

Life Stage

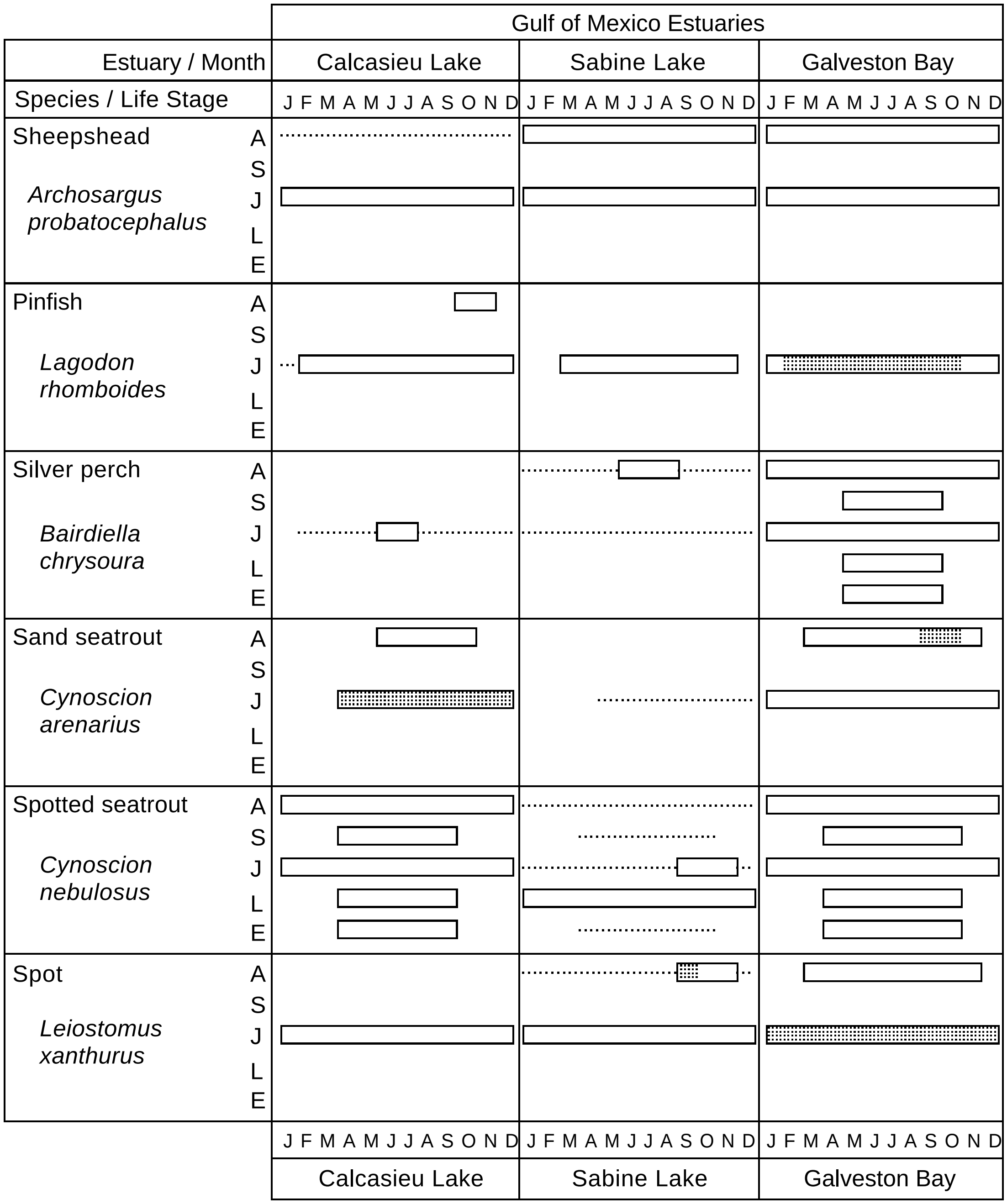
A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance		Life Stage
(solid black bar)	Highly Abundant	A - Adults
(stippled bar)	Abundant	S - Spawning adults
(open bar)	Common	J - Juveniles
....	Rare	L - Larvae
Blank	Not Present	E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

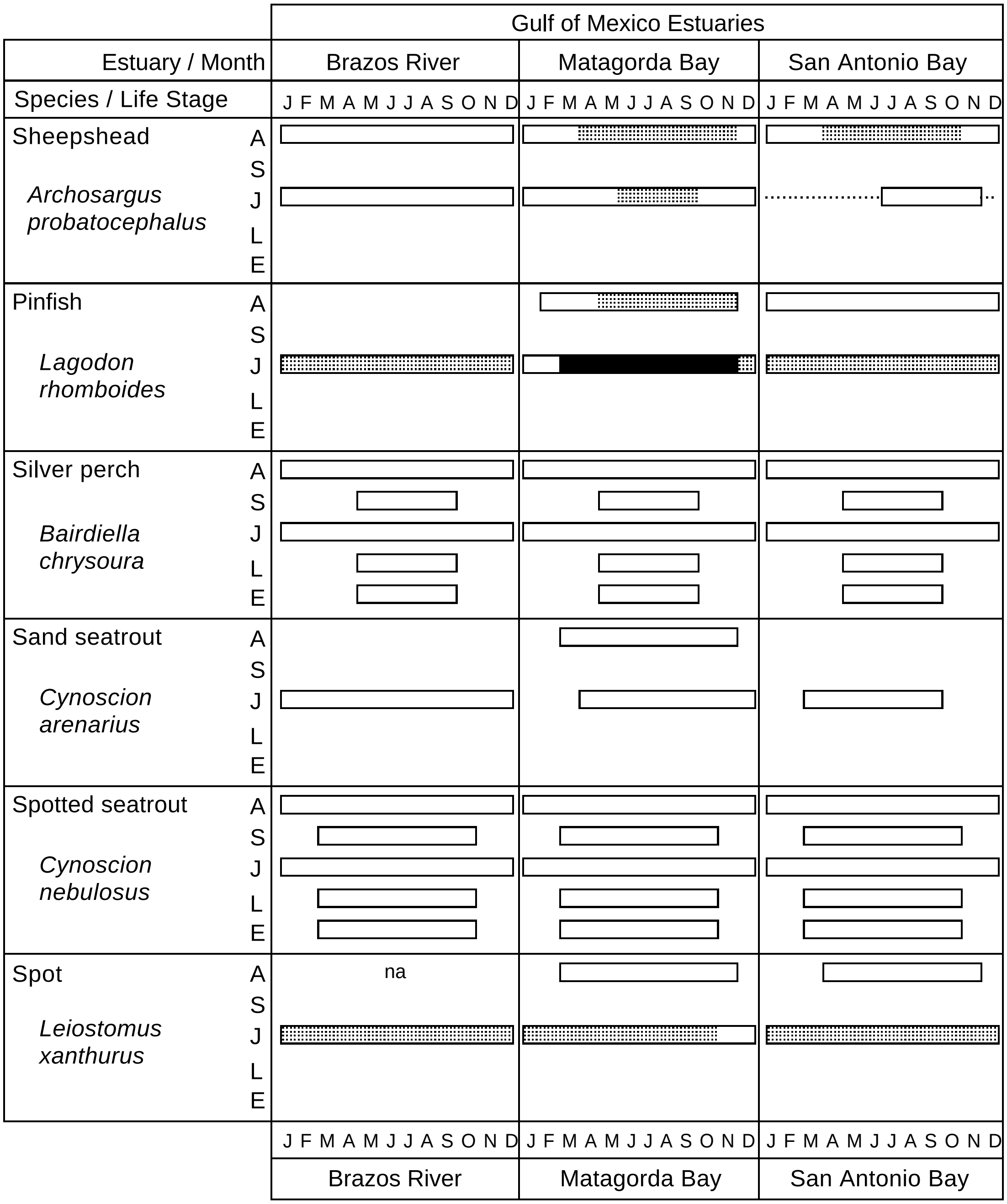
Rare

Blank   Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



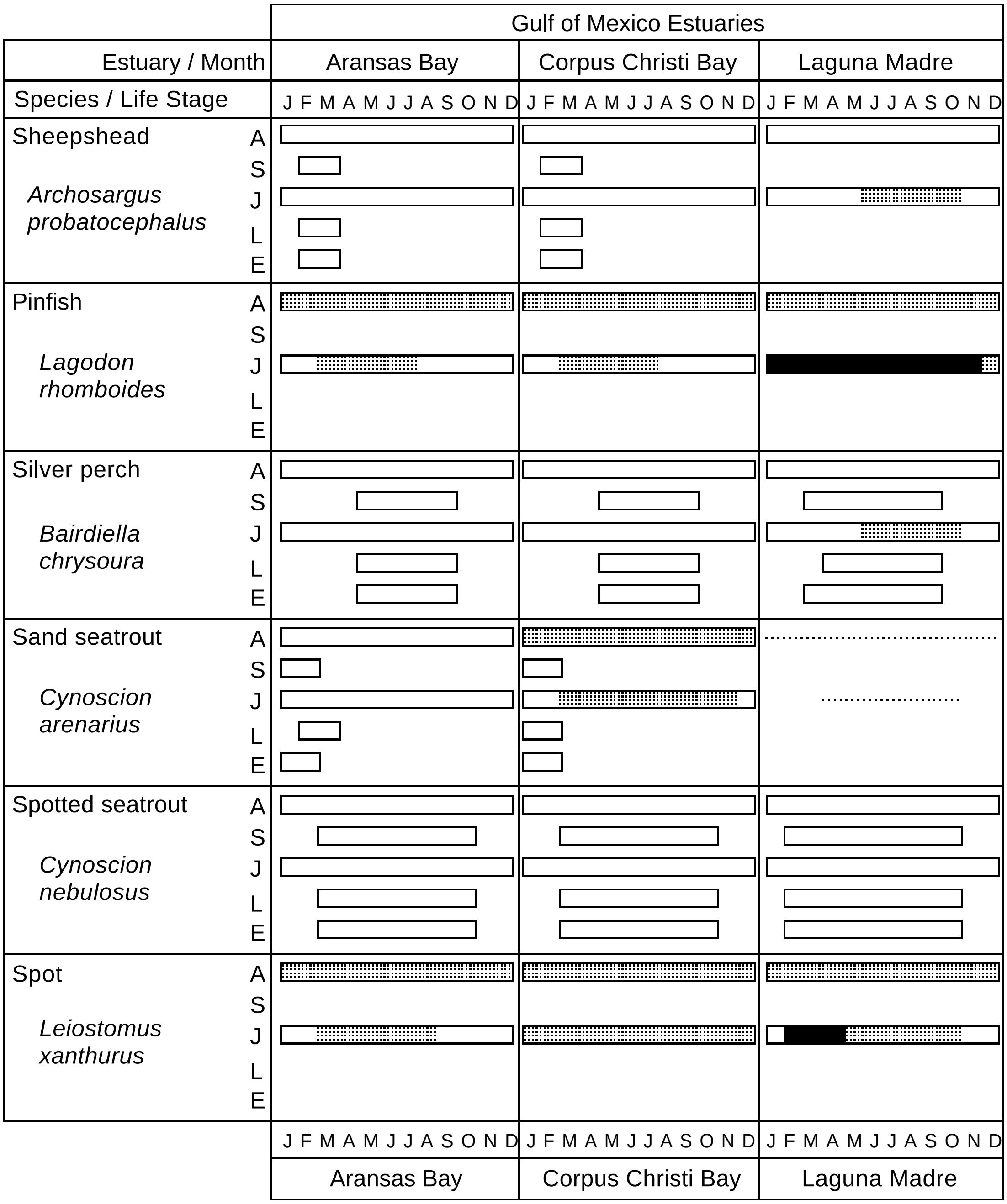
Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank: Not Present
- n: No Data Available

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

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Life Stage

A - Adults
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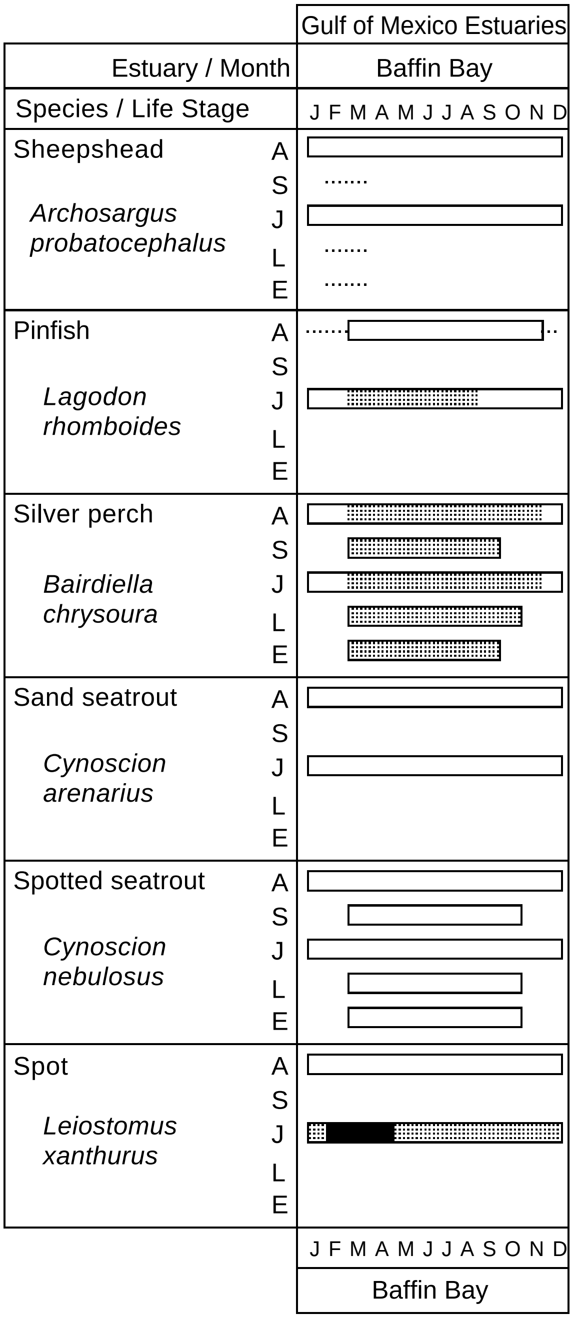
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

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Life Stage

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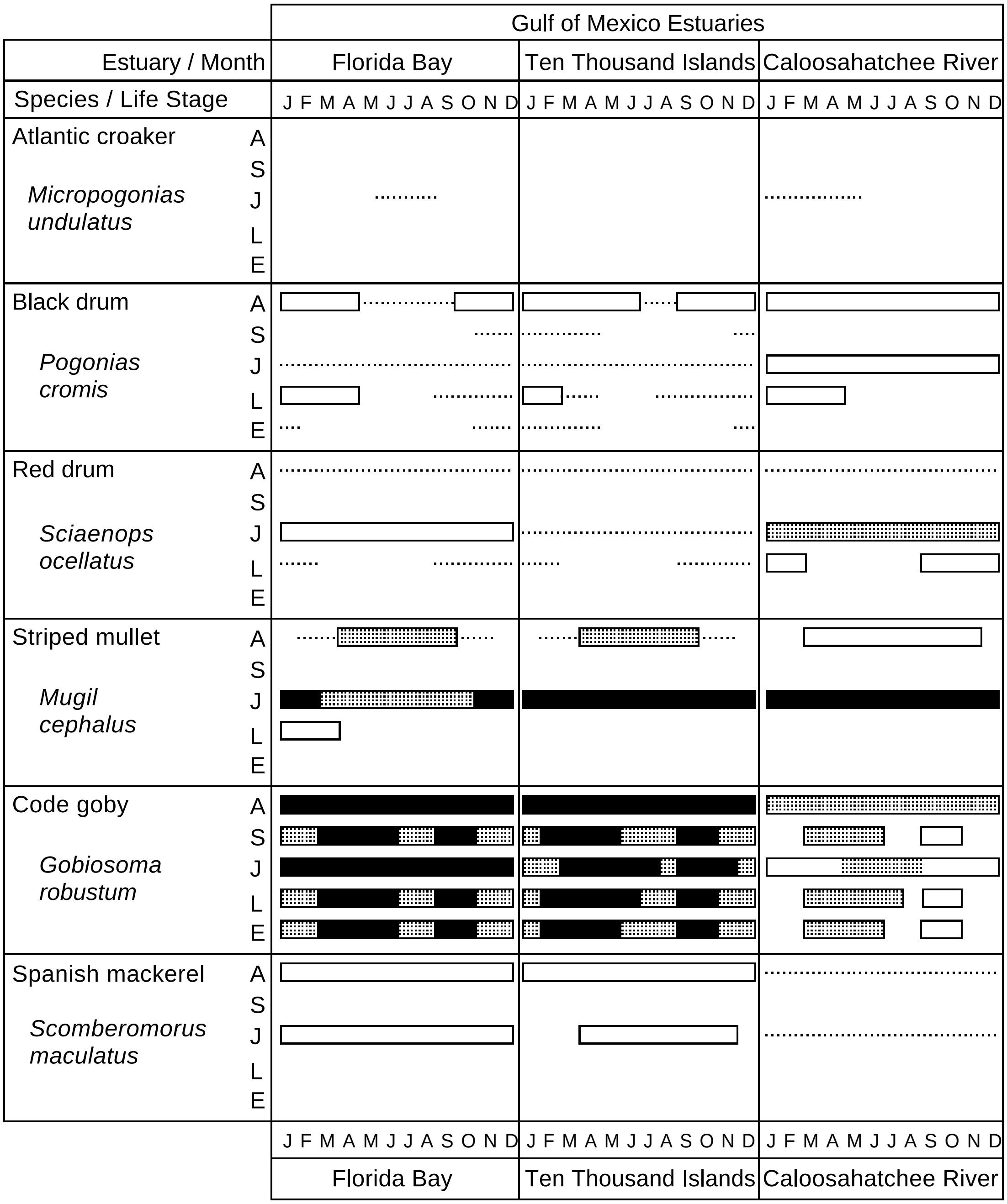
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

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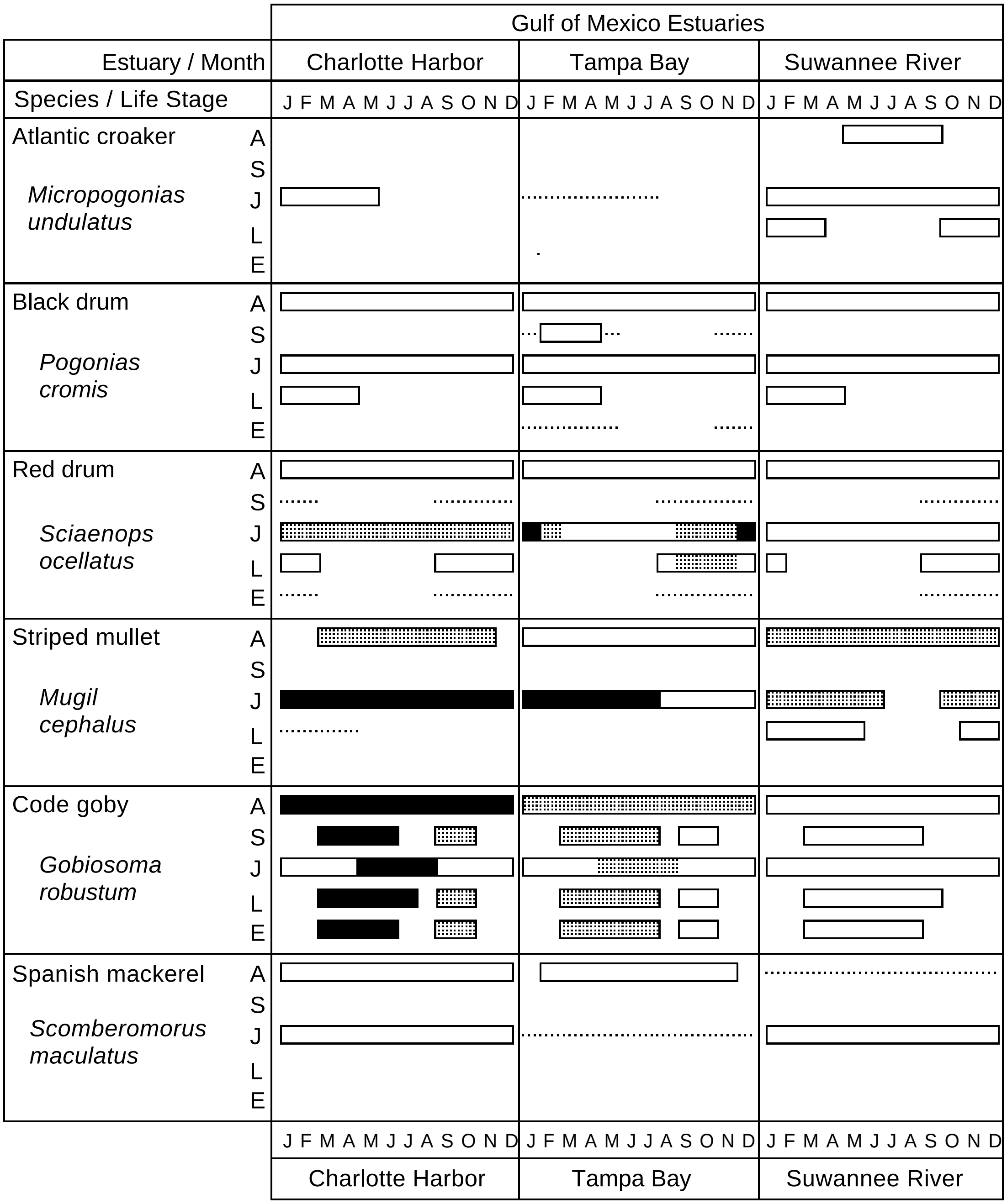
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

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Life Stage

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Table 5, continued. Temporal distribution

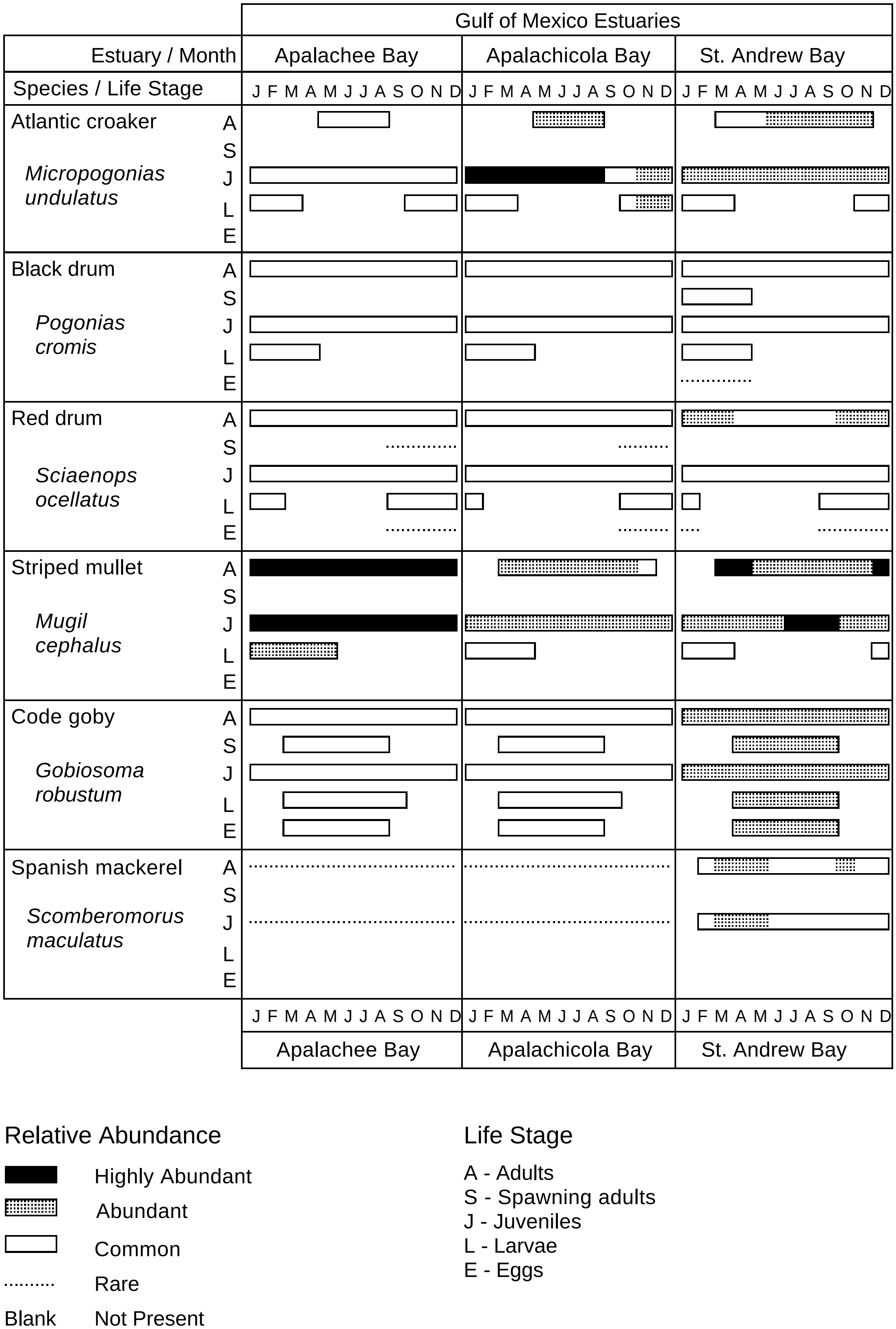
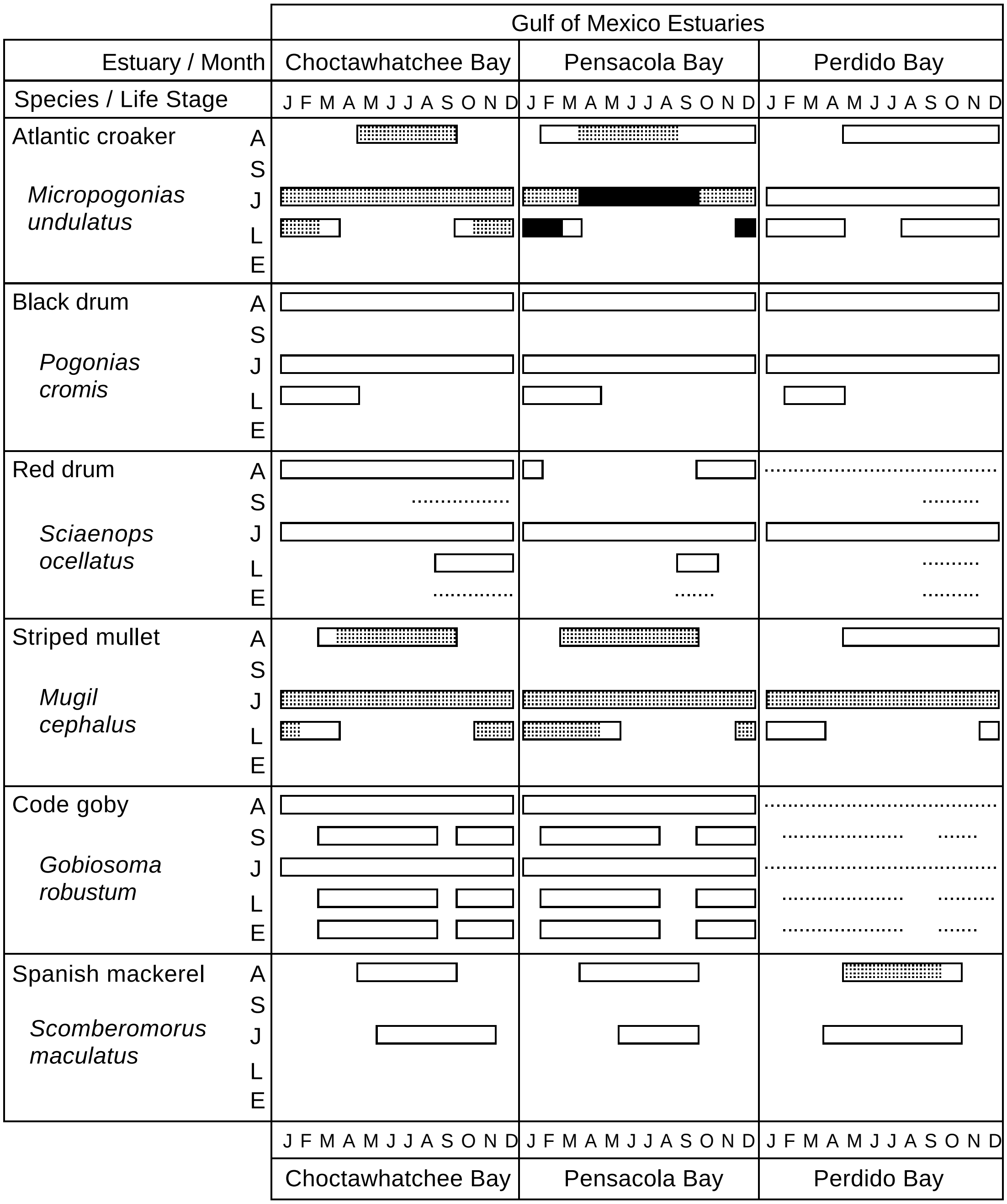


Table 5, continued. Temporal distribution



Relative Abundance

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Life Stage

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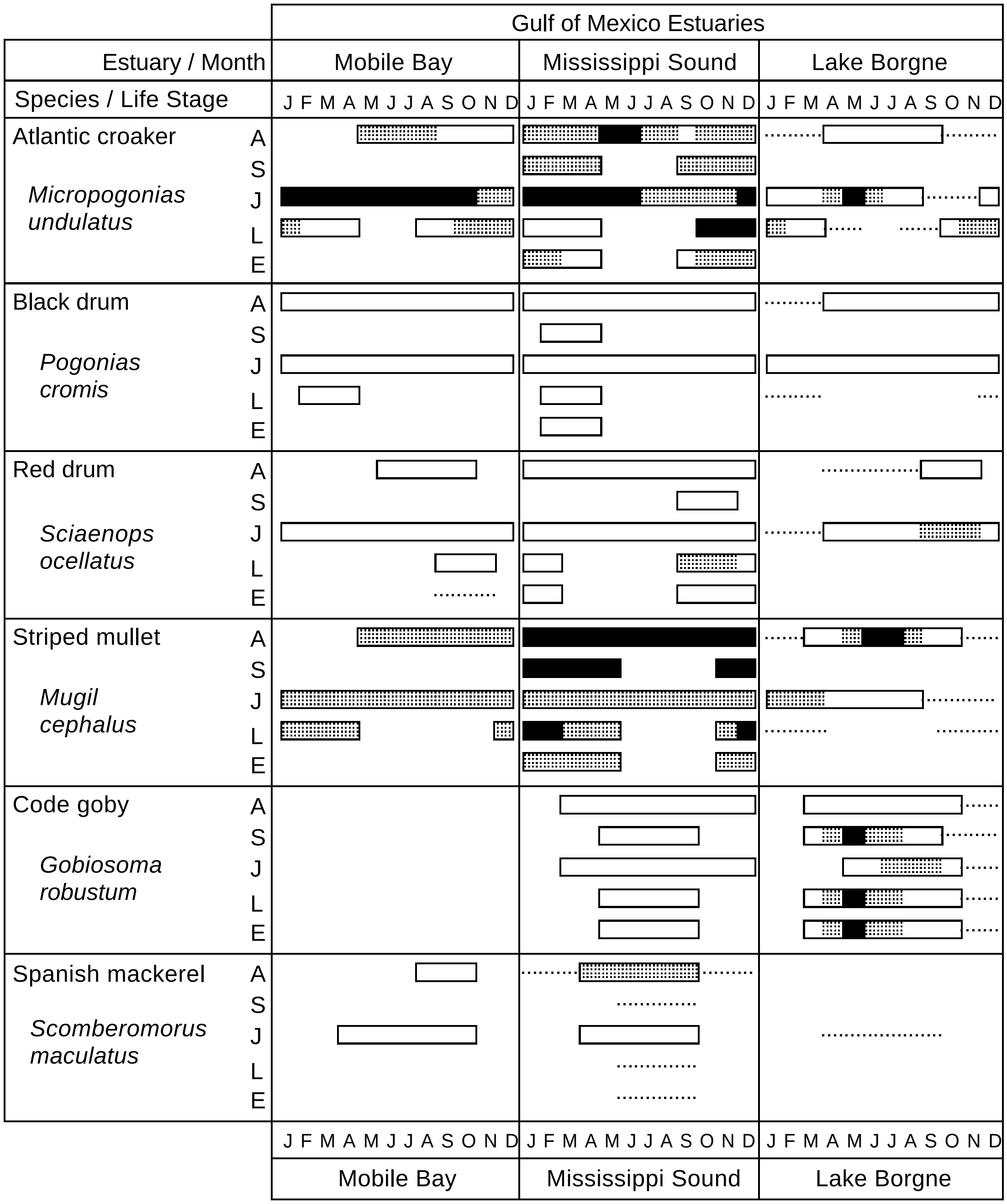
Table 5, continued. Temporal distribution



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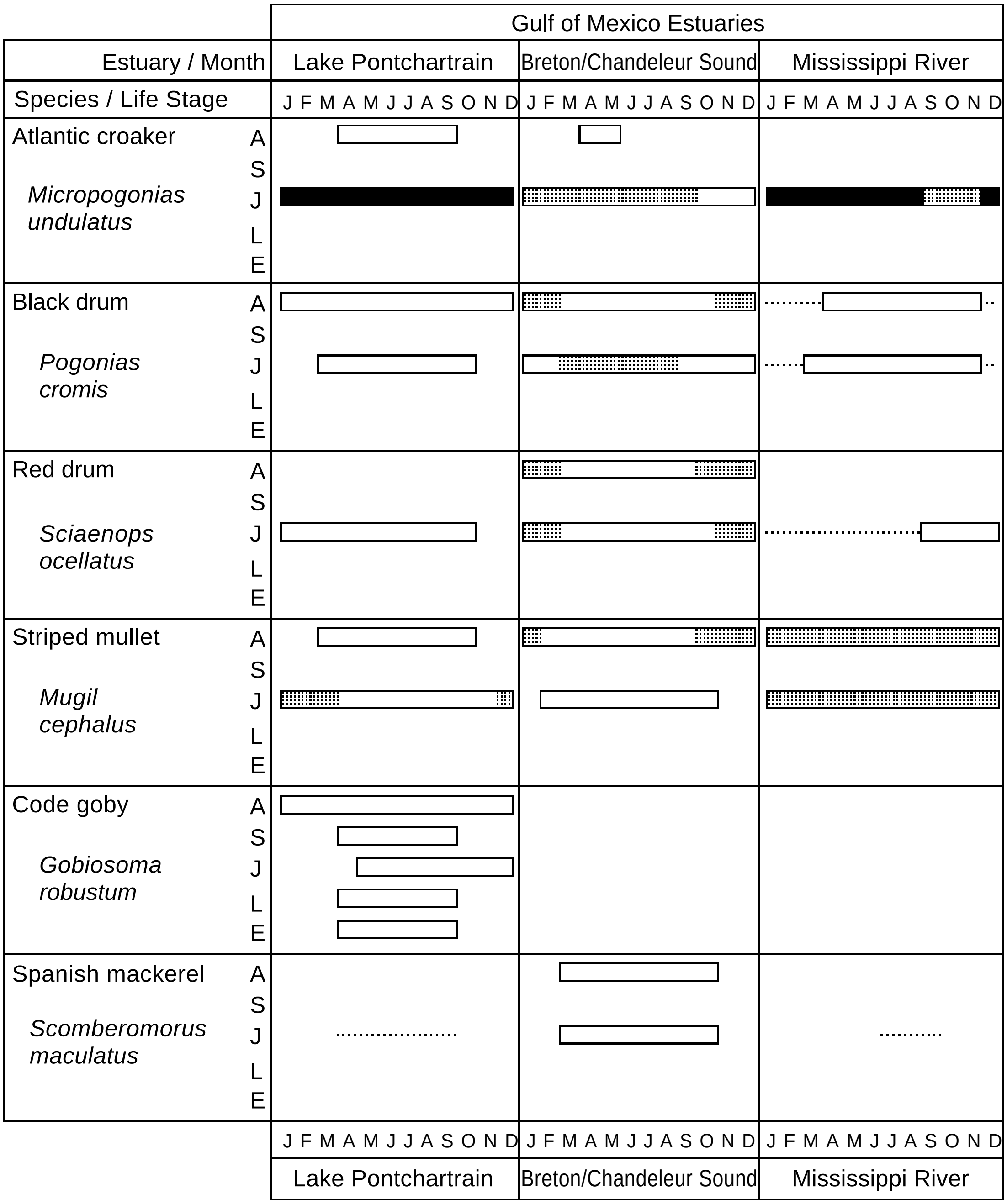

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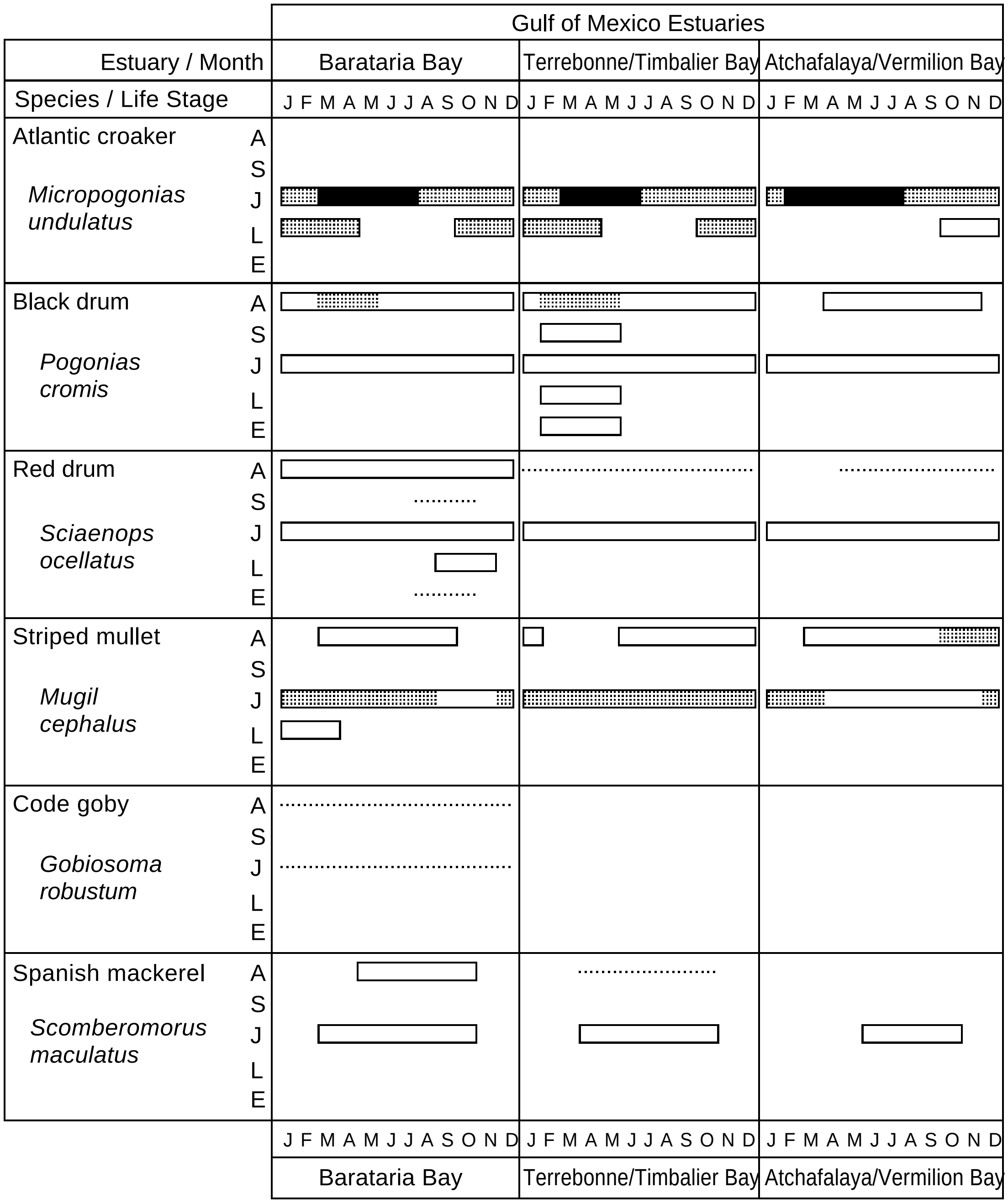
Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

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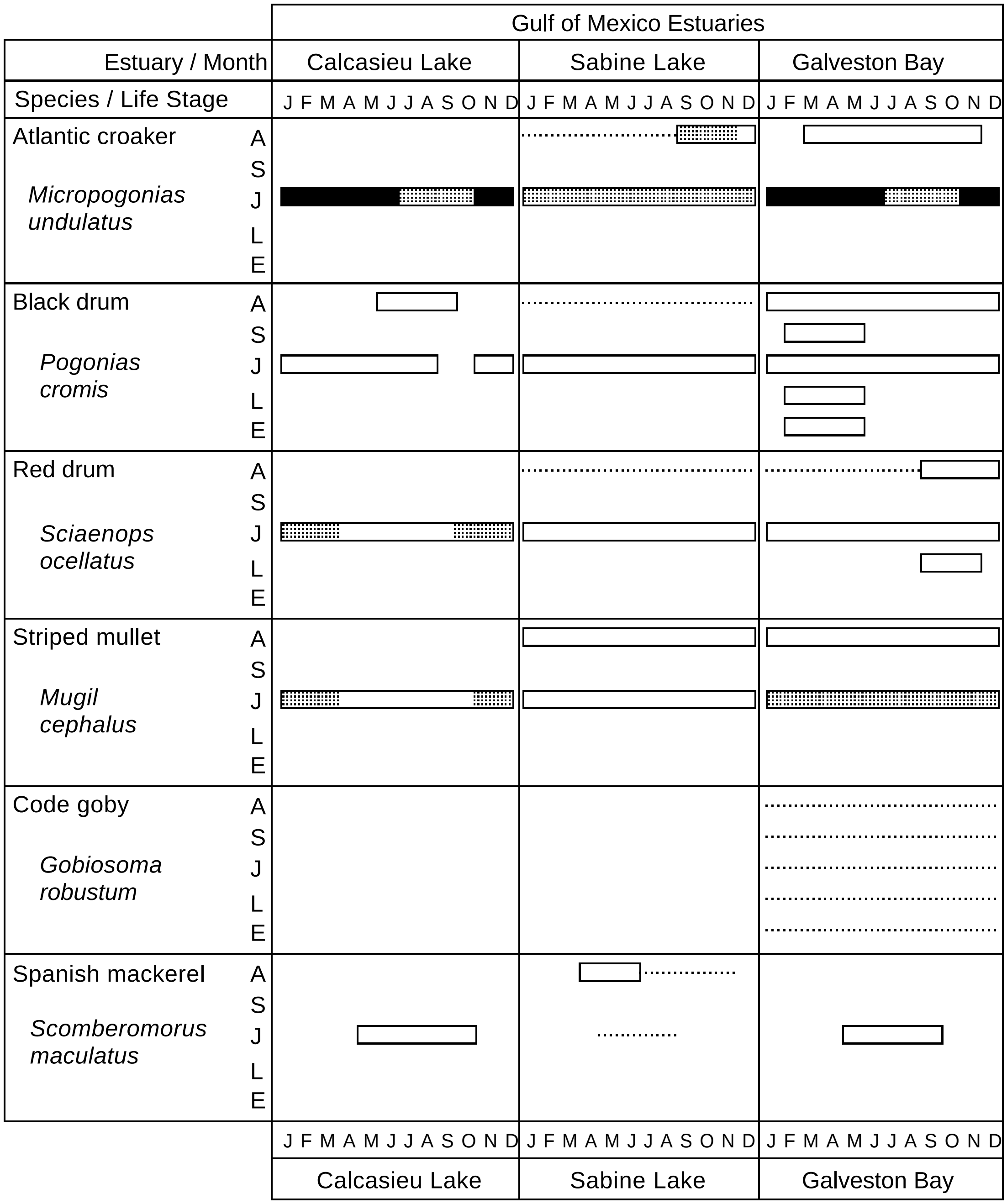

Relative Abundance

Highly Abundant

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Common

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Blank Not Present

Life Stage

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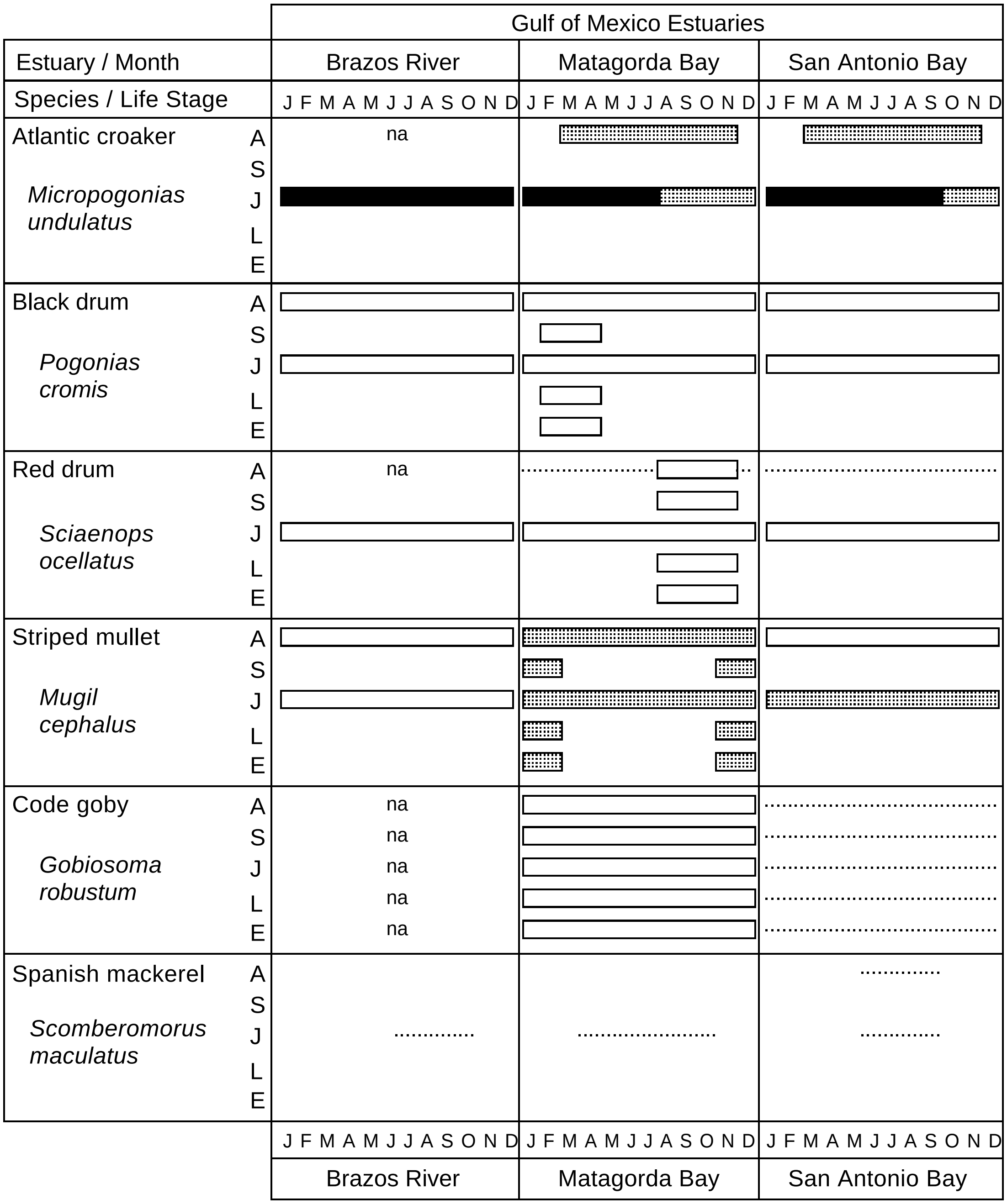
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

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- Abundant
- Common
- Rare
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Life Stage

A - Adults
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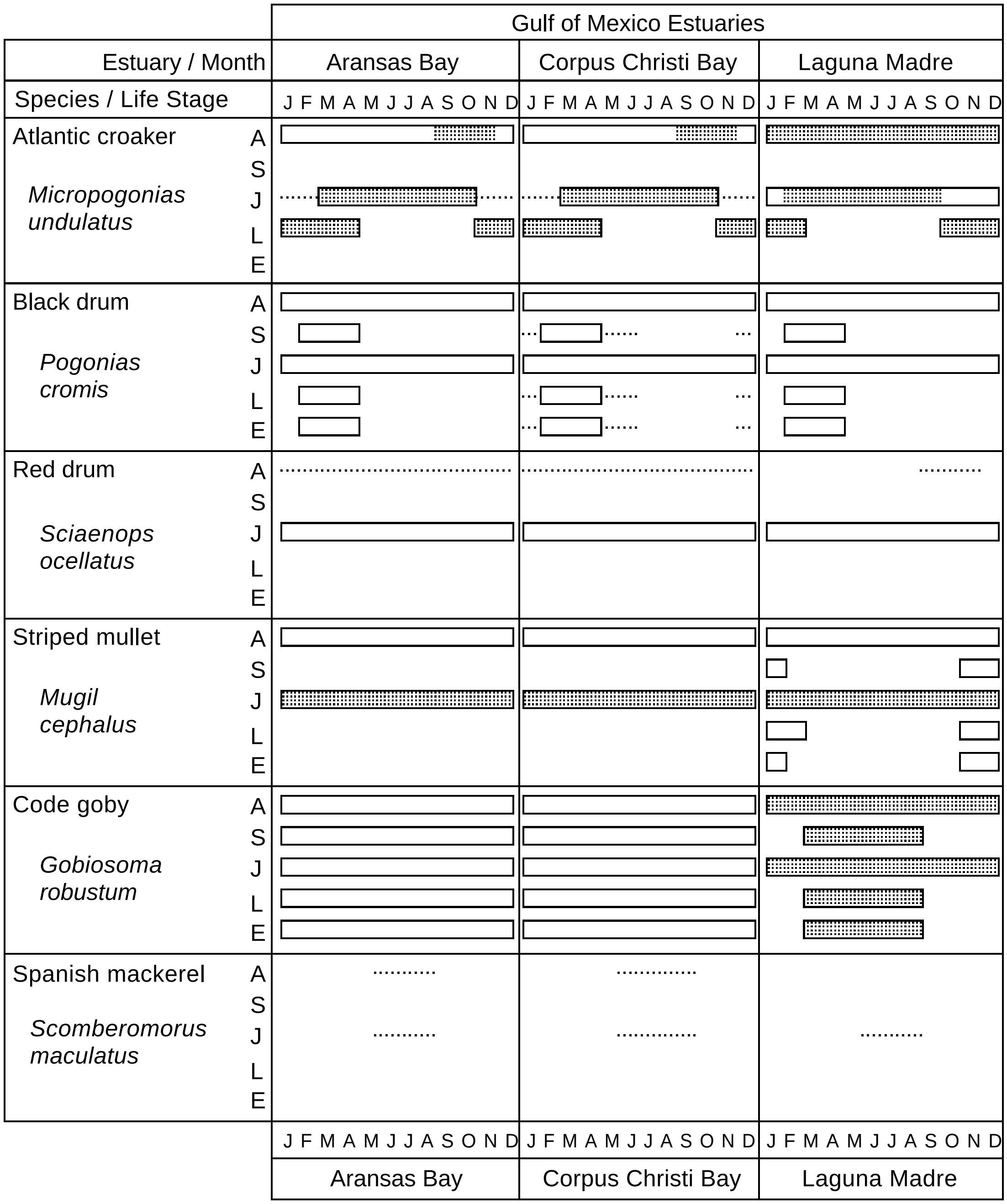
Table 5, continued. Temporal distribution



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Life Stage

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S - Spawning adults
J - Juveniles
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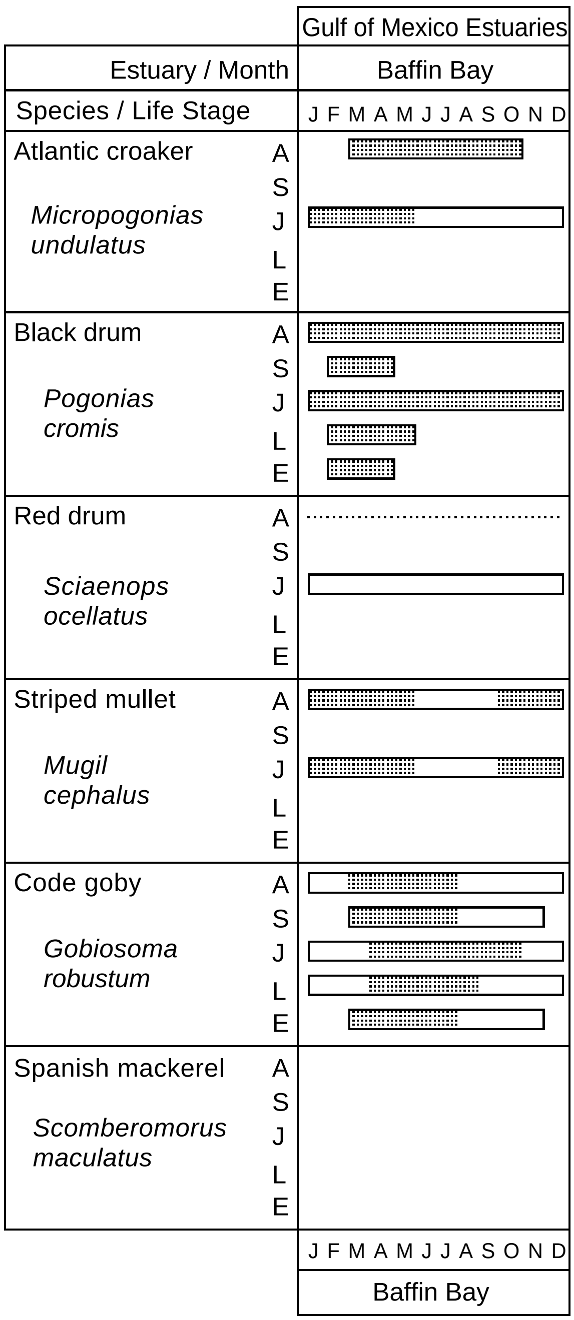
Table 5, continued. Temporal distribution

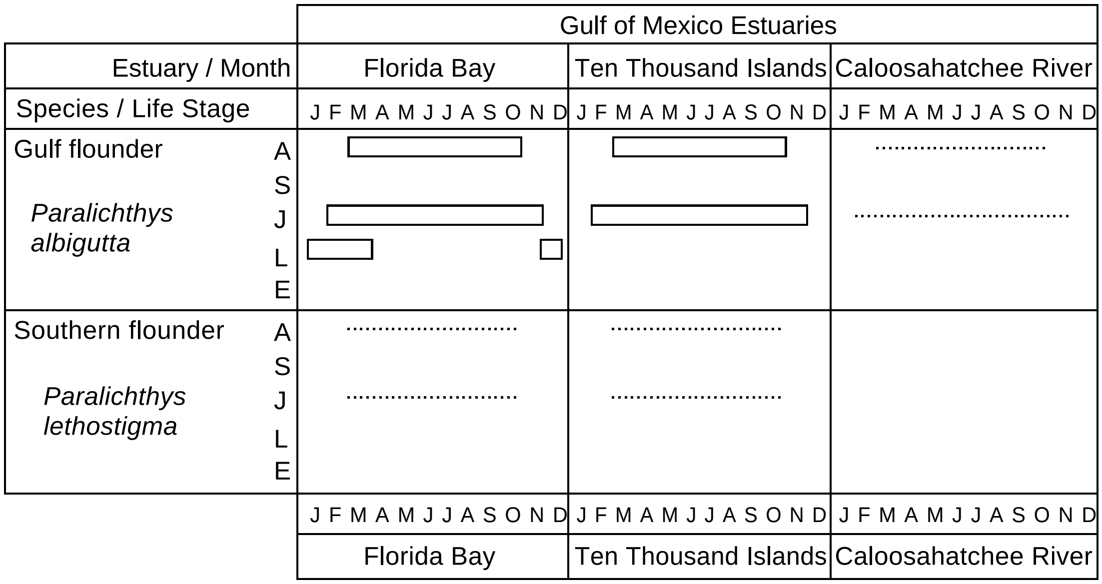


Relative Abundance	
(solid black bar)	Highly Abundant
(stippled bar)	Abundant
(open bar)	Common
....	Rare
Blank	Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



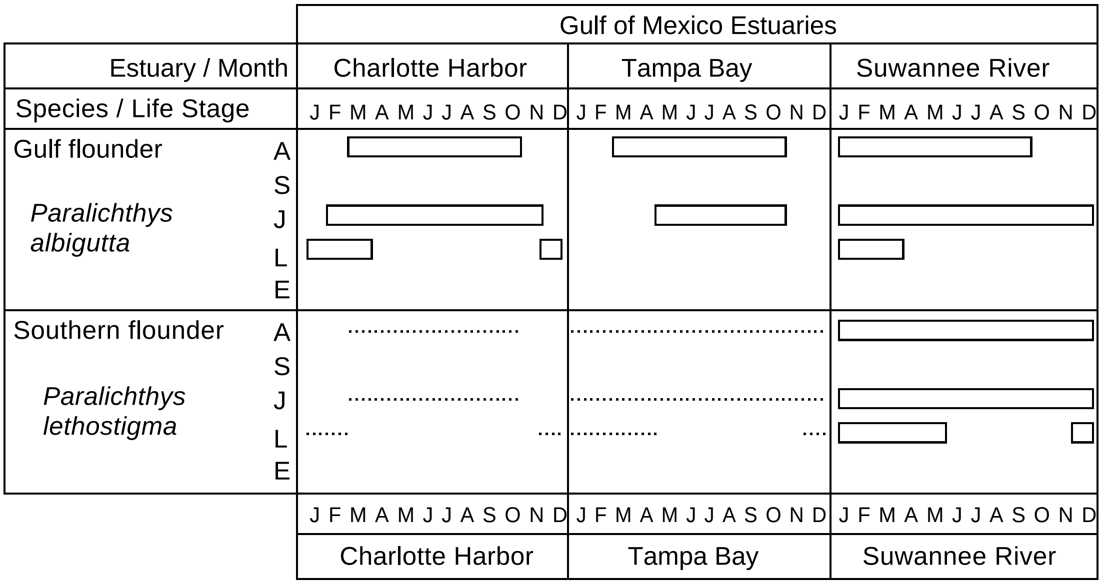
Relative Abundance

(solid black bar)	Highly Abundant
(stippled bar)	Abundant
(open bar)	Common
....	Rare
Blank	Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

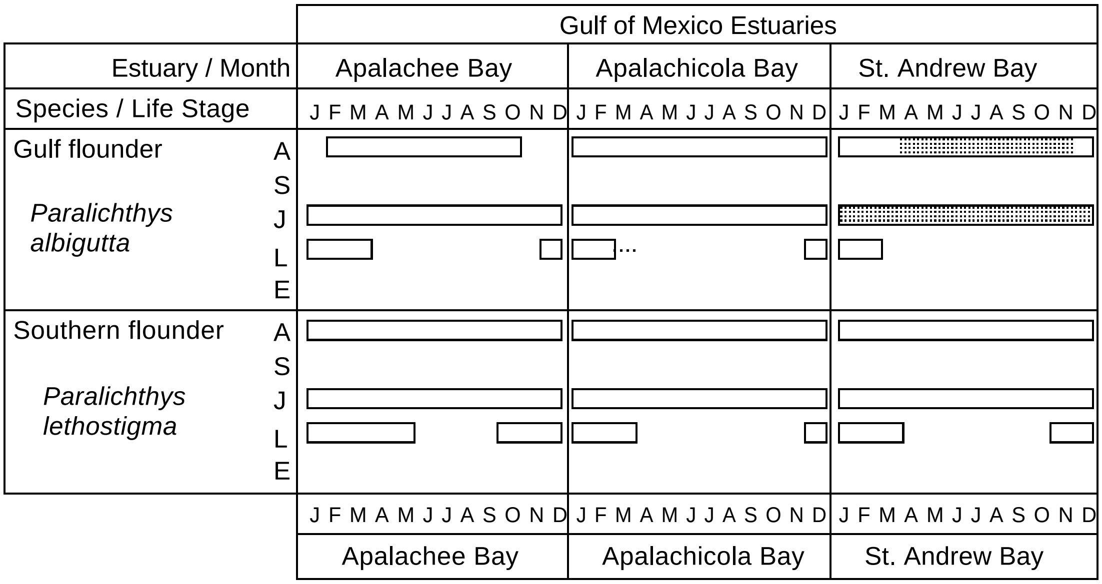
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

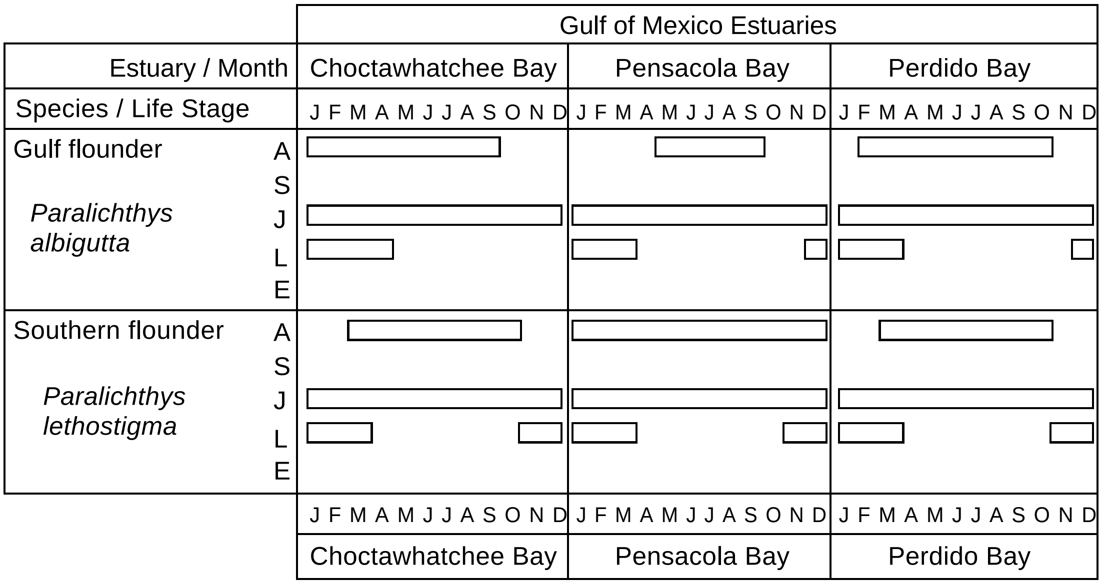
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



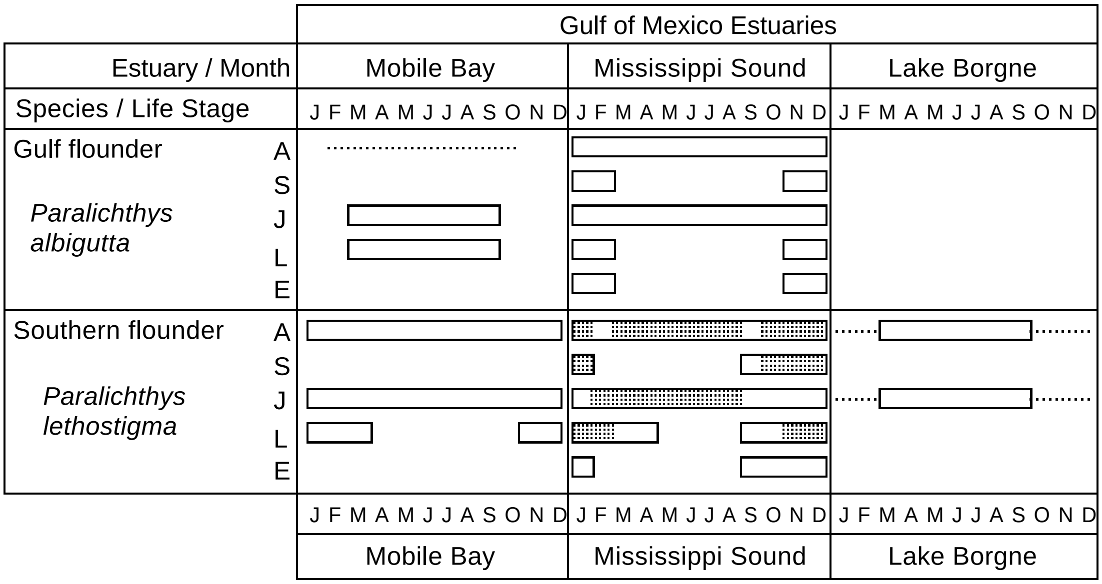
Relative Abundance

Highly Abundant
Abundant
Common
Rare
Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

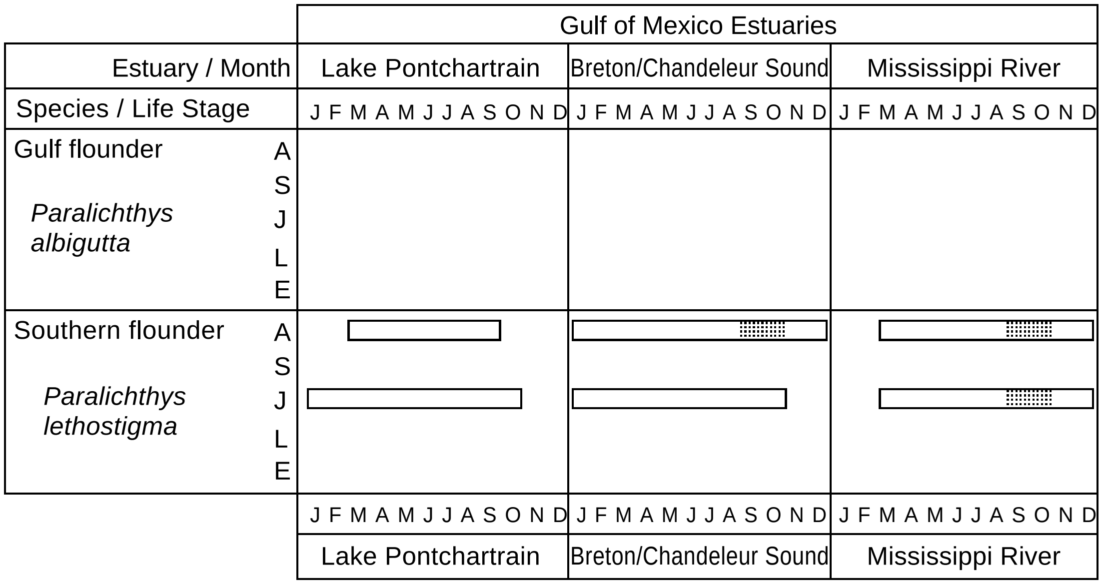
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

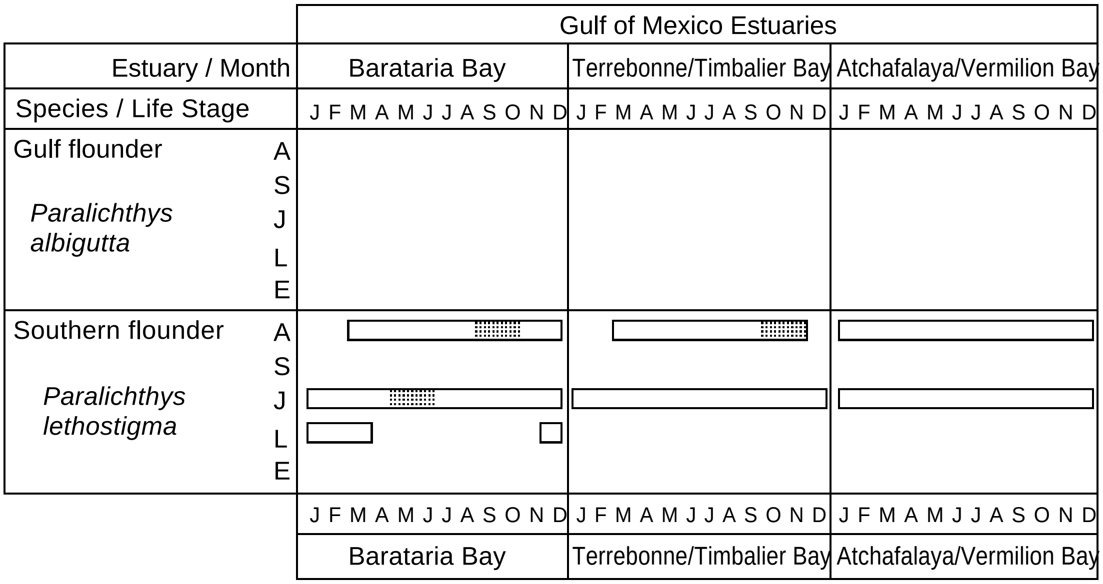
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



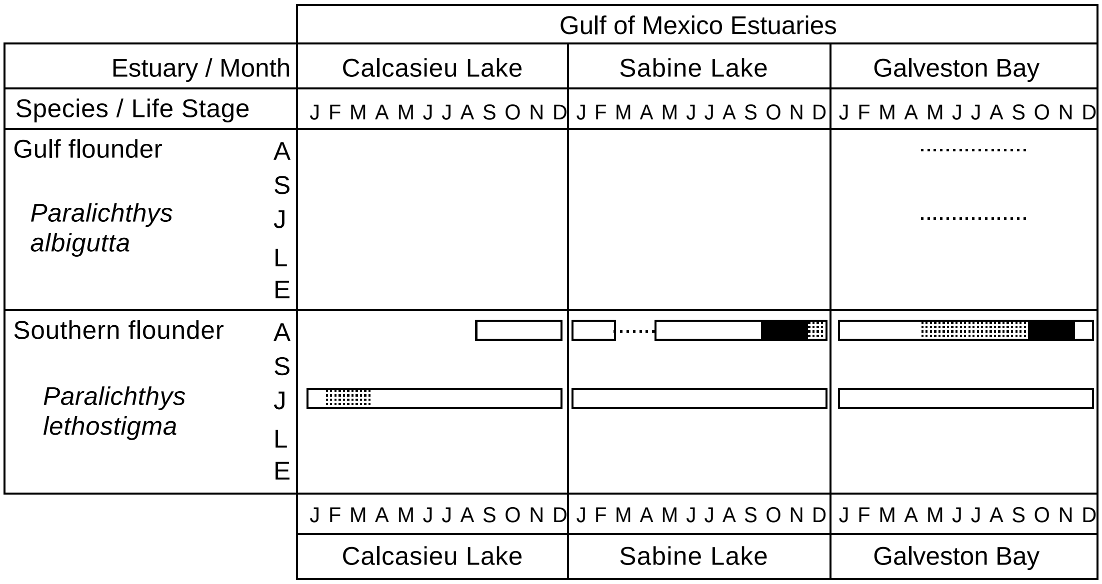
Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank — Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

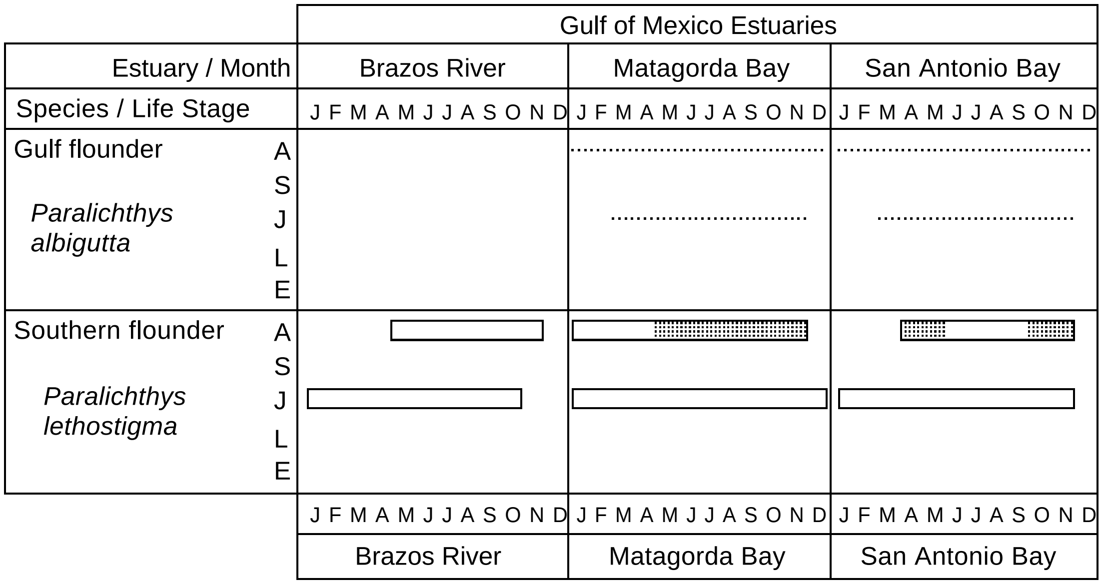
Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



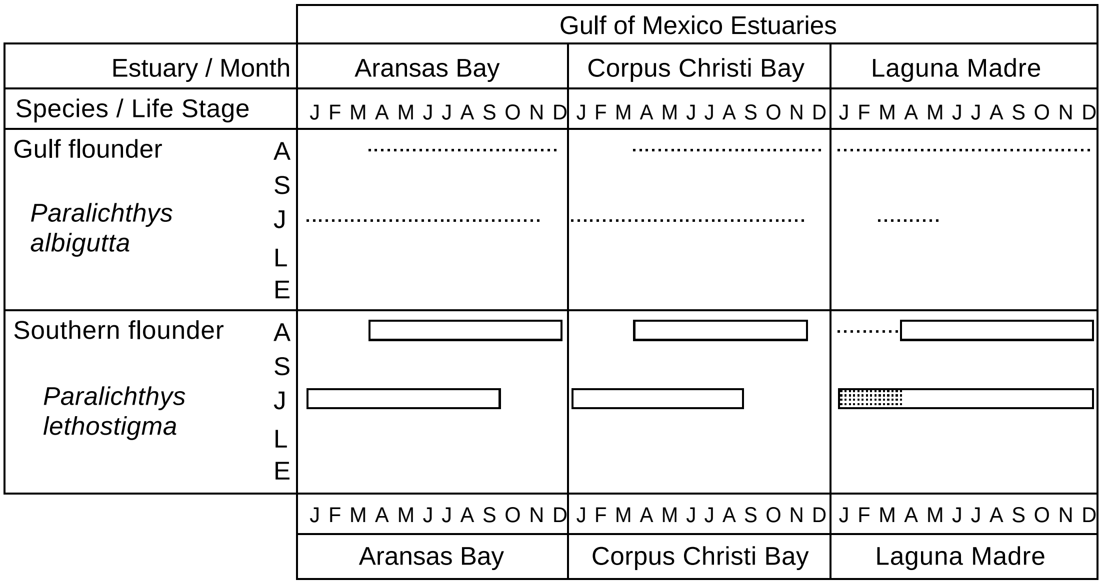
Relative Abundance

- Highly Abundant
- Abundant
- Common
- Rare
- Blank — Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution



Relative Abundance

Highly Abundant

Abundant

Common

Rare

Blank Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 5, continued. Temporal distribution

		Gulf of Mexico Estuaries											
Estuary / Month		Baffin Bay											
Species / Life Stage		J	F	M	A	M	J	J	A	S	O	N	D
Gulf flounder *Paralichthys albigutta*	A												
	S												
	J			Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare		
	L												
	E												
Southern flounder *Paralichthys lethostigma*	A				Common	Common	Common	Common	Common	Common	Common	Common	
	S												
	J	Rare	Rare	Rare	Rare	Rare	Common	Common	Common	Rare	Rare	Rare	Rare
	L												
	E												
		J	F	M	A	M	J	J	A	S	O	N	D
		Baffin Bay											

Relative Abundance

▬	Highly Abundant
▒	Abundant
▭	Common
....	Rare
Blank	Not Present

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6. Data reliability

Index to Table 6. Page location of data reliability table for each species and estuary.

Common and Scientific Name	Estuary: Florida Bay, Ten Thousand Islands, Caloosahatchee River, Charlotte Harbor, Tampa Bay, Suwannee River, Apalachee Bay	Apalachicola Bay, St. Andrew Bay, Choctawhatchee Bay, Pensacola Bay, Perdido Bay, Mobile Bay, Mississippi Sound	Lake Borgne, Breton/Chandeleur Sound, Lake Pontchartrain, Mississippi River, Barataria Bay, Terrebonne/Timbalier Bay, Atchafalaya/Vermilion Bay	Calcasieu Lake, Sabine Lake, Galveston Bay, Brazos River, Matagorda Bay, San Antonio Bay, Aransas Bay	Corpus Christi Bay, Laguna Madre, Baffin Bay
Bay scallop (*Argopecten irradians*) American oyster (*Crassostrea virginica*) Common rangia (*Rangia cuneata*) Hard clam (*Mercenaria* species) Bay squid (*Lolliguncula brevis*) Brown shrimp (*Penaeus aztecus*)	152	153	154	155	156
Pink shrimp (*Penaeus duorarum*) White shrimp (*Penaeus setiferus*) Grass shrimp (*Palaemonetes pugio*) Spiny lobster (*Panulirus argus*) Blue crab (*Callinectes sapidus*) Gulf stone crab (*Menippe adina*)	157	158	159	160	161
Stone crab (*Menippe mercenaria*) Bull shark (*Carcharhinus leucas*) Tarpon (*Megalops atlanticus*) Alabama shad (*Alosa alabamae*) Gulf menhaden (*Brevoortia patronus*) Yellowfin menhaden (*Brevoortia smithi*)	162	163	164	165	166
Gizzard shad (*Dorosoma cepedianum*) Bay anchovy (*Anchoa mitchilli*) Hardhead catfish (*Arius felis*) Sheepshead minnow (*Cyprinodon variegatus*) Gulf killifish (*Fundulus grandis*) Silversides (*Menidia* species)	167	168	169	170	171
Snook (*Centropomus undecimalis*) Bluefish (*Pomatomus saltatrix*) Blue runner (*Caranx crysos*) Crevalle jack (*Caranx hippos*) Florida pompano (*Trachinotus carolinus*) Gray snapper (*Lutjanus griseus*)	172	173	174	175	176
Sheepshead (*Archosargus probatocephalus*) Pinfish (*Lagodon rhomboides*) Silver perch (*Bairdiella chrysoura*) Sand seatrout (*Cynoscion arenarius*) Spotted seatrout (*Cynoscion nebulosus*) Spot (*Leiostomus xanthurus*)	177	178	179	180	181
Atlantic croaker (*Micropogonias undulatus*) Black drum (*Pogonias cromis*) Red drum (*Sciaenops ocellatus*) Striped mullet (*Mugil cephalus*) Code goby (*Gobiosoma robustum*) Spanish mackerel (*Scomberomorus maculatus*)	182	183	184	185	186
Gulf flounder (*Paralichthys albigutta*) Southern flounder (*Paralichthys lethostigma*)	187	188	189	190	191

Table 6. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Florida Bay	Ten Thousand Islands	Caloosa-hatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay
Bay scallop *Argopecten irradians*	A	■	▣	▣	□	▣	■	▣
	S	■	▣	▣	□	▣	■	▣
	J	■	▣	▣	□	▣	■	▣
	L	■	▣	▣	□	▣	■	▣
	E	■	▣	▣	□	▣	■	▣
American oyster *Crassostrea virginica*	A	■	■	■	■	■	▣	▣
	S	■	▣	□	▣	▣	▣	▣
	J	■	▣	■	■	■	▣	▣
	L	■	▣	□	▣	▣	▣	▣
	E	■	▣	□	▣	▣	▣	▣
Common rangia *Rangia cuneata*	A	■	■	▣	▣	▣	▣	▣
	S	■	■	▣	▣	▣	▣	▣
	J	■	■	▣	▣	▣	▣	▣
	L	■	■	▣	▣	▣	▣	▣
	E	■	■	▣	▣	▣	▣	▣
Hard clam *Mercenaria* species	A	■	■	■	▣	▣	■	□
	S	■	■	■	□	▣	▣	□
	J	■	■	■	▣	▣	■	□
	L	■	■	■	□	▣	▣	□
	E	■	■	■	□	▣	▣	□
Bay squid *Lolliguncula brevis*	A	▣	▣	▣	▣	▣	▣	▣
	S	▣	□	□	□	□	□	□
	J	▣	▣	▣	▣	▣	▣	▣
	L	▣	□	□	□	□	□	□
	E	▣	□	□	□	□	□	□
Brown shrimp *Penaeus aztecus*	A	▣	▣	□	▣	▣	■	■
	S	□	■	■	■	■	■	■
	J	▣	▣	□	▣	▣	■	■
	L	□	▣	▣	▣	▣	■	■
	E	□	■	■	■	■	■	■

Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Data Reliability

- ■ Highly Certain
- ▣ Moderately Certain
- □ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
		Gulf of Mexico Estuaries						
Bay scallop	A	▣	■	■	▣	■	■	▣
	S	▣	▣	■	■	■	■	□
Argopecten irradians	J	▣	▣	■	▣	■	■	▣
	L	▣	▣	■	■	■	■	□
	E	▣	▣	■	■	■	■	□
American oyster	A	▣	▣	▣	▣	■	▣	▣
	S	▣	▣	▣	□	■	▣	□
Crassostrea virginica	J	▣	▣	▣	▣	■	▣	▣
	L	▣	▣	▣	□	■	▣	□
	E	▣	▣	▣	□	■	▣	□
Common rangia	A	▣	▣	▣	▣	▣	▣	□
	S	▣	▣	▣	▣	▣	▣	□
Rangia cuneata	J	▣	▣	▣	▣	▣	▣	□
	L	▣	▣	▣	▣	▣	▣	□
	E	▣	▣	▣	▣	▣	▣	□
Hard clam	A	■	▣	▣	■	▣	▣	□
	S	■	▣	▣	■	▣	▣	□
Mercenaria species	J	■	▣	▣	■	▣	▣	□
	L	■	▣	▣	■	▣	▣	□
	E	■	▣	▣	■	▣	▣	□
Bay squid	A	▣	▣	▣	▣	▣	▣	▣
	S	□	□	□	□	□	□	□
Lolliguncula brevis	J	▣	▣	▣	▣	▣	▣	□
	L	□	□	□	□	□	□	□
	E	□	□	□	□	□	□	□
Brown shrimp	A	■	■	■	▣	▣	■	□
	S	■	■	■	■	▣	■	■
Penaeus aztecus	J	■	■	■	■	▣	■	□
	L	■	■	■	■	▣	■	□
	E	■	■	■	■	▣	■	▣

Apalachicola Bay | St. Andrew Bay | Choctawhatchee Bay | Pensacola Bay | Perdido Bay | Mobile Bay | Mississippi Sound
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Lake Borgn	Lake Pontchar-train	Breton/ Chandeleur Sounds	Mississippi River	Barataria Bay	Terrebonne/ Timbalier Bays	Atchafalaya/ Vermilion Bays
		Gulf of Mexico Estuaries						
Bay scallop	A	■	■	▣	■	■	■	▣
	S	■	■	▣	■	■	■	■
Argopecten irradians	J	■	■	▣	■	■	■	▣
	L	■	■	▣	■	■	■	■
	E	■	■	▣	■	■	■	■
American oyster	A	▣	▣	▣	▣	■	□	▣
	S	▣	▣	▣	▣	■	▣	▣
Crassostrea virginica	J	▣	▣	▣	▣	■	□	▣
	L	▣	▣	▣	▣	■	▣	▣
	E	▣	▣	▣	▣	■	▣	▣
Common rangia	A	▣	▣	▣	▣	▣	▣	□
	S	▣	▣	▣	□	▣	▣	□
Rangia cuneata	J	▣	▣	▣	▣	▣	▣	□
	L	▣	▣	▣	□	▣	▣	□
	E	▣	▣	▣	□	▣	▣	□
Hard clam	A	▣	■	▣	■	□	□	□
	S	▣	■	▣	■	□	□	□
Mercenaria species	J	▣	■	▣	■	□	□	□
	L	▣	■	▣	■	□	□	□
	E	▣	■	▣	■	□	□	□
Bay squid	A	▣	□	▣	□	□	▣	▣
	S	□	■	□	■	□	□	▣
Lolliguncula brevis	J	▣	□	▣	□	□	▣	▣
	L	□	■	□	■	□	□	▣
	E	□	■	□	■	□	□	▣
Brown shrimp	A	▣	▣	■	■	▣	■	■
	S	■	■	■	■	▣	■	■
Penaeus aztecus	J	▣	▣	▣	▣	▣	□	▣
	L	□	□	▣	■	□	□	■
	E	■	■	■	■	▣	■	■

Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays

Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay
		Gulf of Mexico Estuaries						
Bay scallop	A	■	▣	▣	▣	□	□	□
	S	■	▣	▣	▣	□	□	□
Argopecten irradians	J	■	▣	▣	▣	□	□	□
	L	■	▣	▣	▣	□	□	□
	E	■	▣	▣	▣	□	□	□
American oyster	A	▣	▣	▣	□	□	▣	▣
	S	▣	□	□	□	□	□	□
Crassostrea virginica	J	▣	▣	▣	□	□	▣	▣
	L	▣	□	□	□	□	□	□
	E	▣	□	□	□	□	□	□
Common rangia	A	▣	▣	▣	□	▣	▣	▣
	S	▣	□	□	□	□	□	□
Rangia cuneata	J	▣	▣	▣	□	▣	▣	▣
	L	▣	□	□	□	□	□	□
	E	▣	□	□	□	□	□	□
Hard clam	A	■	▣	▣	□	▣	□	▣
	S	■	▣	□	□	□	□	□
Mercenaria species	J	■	▣	▣	□	▣	□	▣
	L	■	▣	□	□	□	□	□
	E	■	▣	□	□	□	□	□
Bay squid	A	▣	▣	▣	□	▣	□	▣
	S	■	□	□	□	□	□	□
Lolliguncula brevis	J	▣	▣	▣	□	▣	□	▣
	L	■	□	□	□	□	□	□
	E	■	□	□	□	□	□	□
Brown shrimp	A	■	■	■	■	■	■	■
	S	■	■	■	■	■	■	■
Penaeus aztecus	J	□	■	■	□	■	■	■
	L	□	■	■	□	■	■	■
	E	■	■	■	■	■	■	■

Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay	Laguna Madre	Baffin Bay
Bay scallop	A	□	▣	■
	S	□	□	■
Argopecten irradians	J	□	▣	■
	L	□	□	■
	E	□	□	■
American oyster	A	▣	▣	■
	S	□	□	■
Crassostrea virginica	J	▣	▣	■
	L	□	□	■
	E	□	□	■
Common rangia	A	□	■	■
	S	□	■	■
Rangia cuneata	J	□	■	■
	L	□	■	■
	E	□	■	■
Hard clam	A	▣	▣	■
	S	□	▣	■
Mercenaria species	J	▣	▣	■
	L	□	▣	■
	E	□	▣	■
Bay squid	A	▣	▣	▣
	S	□	□	□
Lolliguncula brevis	J	▣	▣	▣
	L	□	□	□
	E	□	□	□
Brown shrimp	A	■	■	■
	S	■	■	■
Penaeus aztecus	J	■	■	■
	L	■	■	■
	E	■	■	■
		Corpus Christi Bay	Laguna Madre	Baffin Bay
		Gulf of Mexico Estuaries		

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Florida Bay	Ten Thousand Islands	Caloosa-hatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay
		Gulf of Mexico Estuaries						
Pink shrimp *Penaeus duorarum*	A	■	■	■	■	■	▣	▣
	S	■	■	■	■	■	■	■
	J	■	■	□	▣	■	▣	■
	L	■	■	■	■	■	▣	▣
	E	■	■	■	■	■	■	■
White shrimp *Penaeus setiferus*	A	■	■	■	■	■	■	▣
	S	■	■	■	■	■	■	■
	J	■	■	■	■	■	■	▣
	L	■	■	■	■	■	■	▣
	E	■	■	■	■	■	■	■
Grass shrimp *Palaemonetes pugio*	A	▣	▣	▣	▣	▣	□	▣
	S	▣	▣	▣	▣	▣	□	▣
	J	▣	▣	▣	▣	▣	□	▣
	L	▣	▣	▣	▣	▣	□	▣
	E	▣	▣	▣	▣	▣	□	▣
Spiny lobster *Panulirus argus*	A	▣	▣	■	▣	▣	▣	▣
	M	■	■	■	■	■	▣	▣
	J	▣	▣	■	▣	▣	▣	▣
	L	■	■	■	■	■	▣	▣
	E	■	■	■	■	■	▣	▣
Blue crab *Callinectes sapidus*	A	▣	■	■	■	▣	□	▣
	M	▣	■	■	■	▣	▣	▣
	J	▣	■	□	■	▣	▣	▣
	L	□	□	▣	□	□	□	□
	E	▣	■	■	■	▣	▣	▣
Gulf stone crab *Menippe adina*	A	■	■	■	■	■	□	□
	M	■	■	■	■	■	□	□
	J	■	■	■	■	■	□	□
	L	■	■	■	■	■	□	□
	E	■	■	■	■	■	□	□

Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Data Reliability

- ■ Highly Certain
- ▣ Moderately Certain
- □ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 6, continued. Data reliability

Species/Life Stage		Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
		Gulf of Mexico Estuaries						
Pink shrimp	A	▣	■	■	▣	■	■	□
	S	■	■	■	■	■	■	□
Penaeus duorarum	J	■	■	■	■	■	■	□
	L	■	■	■	■	■	▣	▣
	E	■	■	■	■	■	■	□
White shrimp	A	▣	■	■	▣	▣	▣	□
	S	▣	■	■	■	■	■	▣
Penaeus setiferus	J	▣	■	■	■	▣	▣	▣
	L	▣	■	■	■	■	■	▣
	E	▣	■	■	■	■	■	▣
Grass shrimp	A	□	▣	▣	▣	▣	▣	□
	S	□	▣	▣	▣	▣	▣	□
Palaemonetes pugio	J	▣	▣	▣	▣	▣	▣	□
	L	□	▣	▣	▣	▣	▣	□
	E	□	▣	▣	▣	▣	▣	□
Spiny lobster	A	▣	■	■	■	■	■	▣
	M	▣	■	■	■	■	■	▣
Panulirus argus	J	▣	■	■	■	■	□	□
	L	▣	■	■	■	■	■	□
	E	▣	■	■	■	■	■	□
Blue crab	A	▣	▣	▣	▣	▣	▣	▣
	M	▣	▣	▣	▣	▣	▣	■
Callinectes sapidus	J	▣	▣	▣	▣	▣	▣	■
	L	□	▣	□	□	□	□	▣
	E	▣	▣	▣	▣	▣	▣	▣
Gulf stone crab	A	□	▣	□	□	□	□	▣
	M	□	▣	□	□	□	□	▣
Menippe adina	J	□	▣	□	□	□	□	▣
	L	□	▣	□	□	□	□	▣
	E	□	▣	□	□	□	□	▣

Apalachicola Bay | St. Andrew Bay | Choctawhatchee Bay | Pensacola Bay | Perdido Bay | Mobile Bay | Mississippi Sound
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 6, continued. Data reliability

Species/Life Stage		Lake Borgn	Lake Pontchar-train	Breton/ Chandeleur Sounds	Mississippi River	Barataria Bay	Terrebonne/ Timbalier Bays	Atchafalaya/ Vermilion Bays
		Gulf of Mexico Estuaries						
Pink shrimp	A	▣	■	▣	■	□	■	■
	S	■	■	■	■	▣	■	■
Penaeus duorarum	J	▣	▣	▣	■	▣	▣	▣
	L	■	■	■	■	▣	■	■
	E	■	■	■	■	□	■	■
White shrimp	A	▣	▣	□	■	□	▣	▣
	S	■	■	□	■	□	■	■
Penaeus setiferus	J	▣	▣	□	▣	▣	▣	▣
	L	■	■	□	▣	□	▣	▣
	E	■	■	□	■	□	■	■
Grass shrimp	A	▣	▣	▣	▣	▣	▣	▣
	S	▣	▣	▣	▣	▣	▣	▣
Palaemonetes pugio	J	▣	▣	▣	▣	▣	▣	▣
	L	▣	▣	▣	▣	▣	▣	▣
	E	▣	▣	▣	▣	▣	▣	▣
Spiny lobster	A	■	■	■	■	■	■	■
	M	■	■	■	■	■	■	■
Panulirus argus	J	■	■	■	■	■	■	■
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Blue crab	A	▣	▣	▣	▣	□	□	■
	M	□	▣	▣	□	□	□	■
Callinectes sapidus	J	▣	▣	▣	▣	□	□	■
	L	▣	▣	▣	▣	▣	□	■
	E	▣	▣	▣	□	▣	▣	■
Gulf stone crab	A	▣	▣	▣	▣	□	□	□
	M	▣	■	▣	□	□	□	□
Menippe adina	J	▣	▣	▣	▣	□	□	□
	L	▣	■	▣	□	□	□	□
	E	▣	■	▣	□	□	□	□

Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays

Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries						
		Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay
Pink shrimp	A	■	■	▣	■	▣	▣	▣
	S	■	■	■	■	■	■	■
Penaeus duorarum	J	■	■	▣	□	▣	▣	▣
	L	■	■	■	■	▣	▣	▣
	E	■	■	■	■	■	■	■
White shrimp	A	□	■	■	□	■	■	■
	S	■	■	■	■	■	■	■
Penaeus setiferus	J	□	■	■	□	■	■	■
	L	□	■	■	□	■	■	■
	E	■	■	■	■	■	■	■
Grass shrimp	A	▣	▣	▣	□	▣	▣	▣
	S	▣	□	▣	□	▣	▣	▣
Palaemonetes pugio	J	▣	▣	▣	□	▣	▣	▣
	L	▣	□	▣	□	▣	▣	▣
	E	▣	□	▣	□	▣	▣	▣
Spiny lobster	A	■	■	■	■	■	■	■
	M	■	■	■	■	■	■	■
Panulirus argus	J	■	■	■	■	■	■	■
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Blue crab	A	■	▣	■	□	▣	▣	▣
	M	■	▣	■	□	▣	□	▣
Callinectes sapidus	J	■	▣	■	□	▣	▣	▣
	L	■	▣	■	□	□	□	▣
	E	■	▣	■	□	□	□	▣
Gulf stone crab	A	□	▣	▣	□	▣	▣	▣
	M	□	□	▣	■	▣	□	▣
Menippe adina	J	□	▣	▣	□	▣	▣	▣
	L	□	□	▣	■	▣	▣	▣
	E	□	□	▣	■	▣	□	▣

Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain
▣ Moderately Certain
□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay	Laguna Madre	Baffin Bay
Pink shrimp	A	■	▣	▣
	S	■	■	□
Penaeus duorarum	J	▣	▣	▣
	L	▣	■	□
	E	■	■	□
White shrimp	A	■	■	■
	S	■	■	■
Penaeus setiferus	J	■	■	■
	L	▣	■	■
	E	■	■	■
Grass shrimp	A	▣	▣	■
	S	▣	▣	■
Palaemonetes pugio	J	▣	▣	■
	L	▣	▣	■
	E	▣	▣	■
Spiny lobster	A	■	□	■
	M	■	□	■
Panulirus argus	J	■	□	■
	L	■	□	■
	E	■	□	■
Blue crab	A	■	▣	■
	M	▣	▣	□
Callinectes sapidus	J	■	▣	■
	L	▣	▣	□
	E	▣	▣	□
Gulf stone crab	A	▣	▣	▣
	M	▣	▣	□
Menippe adina	J	▣	▣	▣
	L	▣	▣	□
	E	▣	▣	□
		Corpus Christi Bay	Laguna Madre	Baffin Bay
		Gulf of Mexico Estuaries		

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating

Table 6, continued. Data reliability

Species/Life Stage		Florida Bay	Ten Thousand Islands	Caloosa-hatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay
		Gulf of Mexico Estuaries						
Stone crab *Menippe mercenaria*	A	■	■	▣	□	■	▣	□
	M	■	■	▣	□	■	▣	□
	J	■	■	▣	□	■	▣	□
	L	■	▣	▣	□	▣	▣	□
	E	■	■	▣	□	■	▣	□
Bull shark *Carcharhinus leucas*	A	▣	□	▣	▣	▣	▣	▣
	M	▣	□	□	□	□	□	□
	J	▣	▣	▣	▣	▣	▣	▣
	P	▣	□	□	□	□	□	□
Tarpon *Megalops atlanticus*	A	▣	▣	▣	▣	▣	■	□
	S	■	■	■	▣	■	■	■
	J	▣	▣	■	■	▣	■	□
	L	□	□	▣	□	▣	■	□
	E	■	■	■	■	■	■	■
Alabama shad *Alosa alabamae*	A	■	■	■	■	■	▣	■
	S	■	■	■	■	■	▣	■
	J	■	■	■	■	■	▣	■
	L	■	■	■	■	■	▣	■
	E	■	■	■	■	■	▣	■
Gulf menhaden *Brevoortia patronus*	A	▣	▣	▣	□	■	□	▣
	S	▣	▣	■	■	■	□	■
	J	▣	▣	□	□	■	□	▣
	L	▣	▣	▣	□	▣	□	▣
	E	▣	▣	■	■	■	□	■
Yellowfin menhaden *Brevoortia smithi*	A	□	□	■	▣	■	□	▣
	S	□	■	■	■	■	□	■
	J	□	▣	▣	▣	■	□	▣
	L	□	▣	▣	□	■	□	▣
	E	□	■	■	■	■	□	■

Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating
P - Parturition

Table 6, continued. Data reliability

Species/Life Stage		Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
		Gulf of Mexico Estuaries						
Stone crab *Menippe mercenaria*	A	□	■	■	■	■	■	■
	M	□	■	■	■	■	■	■
	J	□	■	■	■	■	■	■
	L	□	■	■	■	■	■	■
	E	□	■	■	■	■	■	■
Bull shark *Carcharhinus leucas*	A	▣	▣	▣	▣	▣	▣	□
	M	□	□	□	□	□	□	▣
	J	▣	▣	▣	▣	▣	▣	□
	P	□	□	□	□	□	□	■
Tarpon *Megalops atlanticus*	A	▣	▣	□	□	▣	▣	□
	S	▣	■	■	■	■	■	□
	J	▣	▣	□	□	▣	▣	▣
	L	▣	▣	□	□	■	▣	□
	E	▣	■	■	□	■	■	□
Alabama shad *Alosa alabamae*	A	▣	▣	▣	■	■	▣	□
	S	▣	■	■	■	■	■	▣
	J	▣	▣	▣	■	■	▣	□
	L	▣	■	■	■	■	■	▣
	E	▣	▣	■	▣	■	■	▣
Gulf menhaden *Brevoortia patronus*	A	▣	▣	▣	▣	▣	▣	□
	S	■	■	▣	■	■	■	□
	J	□	▣	▣	▣	▣	▣	□
	L	▣	▣	▣	▣	▣	■	□
	E	■	■	▣	■	▣	□	□
Yellowfin menhaden *Brevoortia smithi*	A	■	■	■	■	■	■	▣
	S	■	■	■	■	■	■	□
	J	■	■	■	■	■	■	□
	L	■	■	■	■	■	■	□
	E	■	■	■	■	■	■	□

	Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
	Gulf of Mexico Estuaries						

Data Reliability

- ■ Highly Certain
- ▣ Moderately Certain
- □ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating
P - Parturition

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Lake Borgn	Lake Pontchar-train	Breton/ Chandeleur Sounds	Mississippi River	Barataria Bay	Terrebonne/ Timbalier Bays	Atchafalaya/ Vermilion Bays
Stone crab	A	■	■	■	■	■	■	■
	M	■	■	■	■	■	■	■
Menippe mercenaria	J	■	■	■	■	■	■	■
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Bull shark	A	▣	■	▣	▣	□	□	□
	M	■	■	■	■	■	■	■
Carcharhinus leucas	J	▣	■	▣	▣	□	□	□
	P	□	▣	□	□	□	□	□
Tarpon	A	▣	▣	▣	▣	▣	□	□
	S	■	■	■	■	□	■	■
Megalops atlanticus	J	▣	▣	■	■	▣	□	■
	L	▣	■	■	■	□	■	■
	E	■	■	■	■	□	■	■
Alabama shad	A	▣	▣	▣	■	■	■	■
	S	■	■	■	■	■	■	■
Alosa alabamae	J	▣	▣	■	■	■	■	■
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Gulf menhaden	A	▣	▣	■	■	□	□	■
	S	■	■	■	■	■	■	■
Brevoortia patronus	J	▣	▣	▣	▣	□	□	▣
	L	▣	□	■	■	▣	■	▣
	E	■	■	■	■	■	■	■
Yellowfin menhaden	A	▣	□	■	■	■	■	■
	S	■	■	■	■	■	■	■
Brevoortia smithi	J	▣	□	■	■	■	■	■
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■

Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays

Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating
P - Parturition

Table 6, continued. Data reliability

Species/Life Stage		Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay
		Gulf of Mexico Estuaries						
Stone crab	A	■	■	■	■	■	■	■
	M	■	■	■	■	■	■	■
Menippe mercenaria	J	■	■	■	■	■	■	■
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Bull shark	A	□	▣	▣	□	▣	▣	▣
	M	□	▣	▣	□	▣	▣	▣
Carcharhinus leucas	J	□	▣	▣	□	▣	▣	▣
	P	□	■	■	■	■	■	■
								■
Tarpon	A	■	□	▣	▣	▣	▣	▣
	S	■	□	▣	▣	▣	▣	▣
Megalops atlanticus	J	■	□	▣	□	▣	▣	▣
	L	■	□	▣	▣	▣	▣	▣
	E	■	□	▣	▣	▣	▣	▣
Alabama shad	A	■	■	■	□	■	■	■
	S	■	■	■	□	■	■	■
Alosa alabamae	J	■	■	■	□	■	■	■
	L	■	■	■	□	■	■	■
	E	■	■	■	□	■	■	■
Gulf menhaden	A	■	▣	▣	▣	▣	▣	▣
	S	■	■	■	■	■	■	■
Brevoortia patronus	J	□	▣	▣	□	▣	▣	■
	L	□	▣	▣	▣	□	▣	▣
	E	■	■	■	■	■	■	■
Yellowfin menhaden	A	■	■	■	■	■	■	■
	S	■	■	■	■	■	■	■
Brevoortia smithi	J	■	■	■	■	■	■	■
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■

Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay

Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating
P - Parturition

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay	Laguna Madre	Baffin Bay
Stone crab *Menippe mercenaria*	A	■	■	■
	M	■	■	■
	J	■	■	■
	L	■	■	■
	E	■	■	■
Bull shark *Carcharhinus leucas*	A	▣	▣	▣
	M	▣	▣	▣
	J	▣	▣	□
	P	■	■	■
Tarpon *Megalops atlanticus*	A	▣	▣	■
	S	▣	□	■
	J	▣	▣	▣
	L	▣	□	■
	E	▣	□	■
Alabama shad *Alosa alabamae*	A	■	■	■
	S	■	■	■
	J	■	■	■
	L	■	■	■
	E	■	■	■
Gulf menhaden *Brevoortia patronus*	A	▣	▣	▣
	S	■	■	■
	J	▣	▣	■
	L	▣	▣	▣
	E	■	■	■
Yellowfin menhaden *Brevoortia smithi*	A	■	■	■
	S	■	■	■
	J	■	■	■
	L	■	■	■
	E	■	■	■
		Corpus Christi Bay	Laguna Madre	Baffin Bay
		Gulf of Mexico Estuaries		

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs
M - Mating
P - Parturition

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries						
		Florida Bay	Ten Thousand Islands	Caloosa-hatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay
Gizzard shad	A	▣	▣	▣	▣	▣	▣	▣
	S	▣	▣	▣	▣	▣	□	□
Dorosoma cepedianum	J	▣	▣	▣	▣	▣	▣	▣
	L	▣	▣	▣	▣	▣	□	□
	E	▣	▣	▣	▣	▣	□	□
Bay anchovy	A	▣	□	▣	▣	▣	□	▣
	S	▣	▣	▣	■	▣	□	▣
Anchoa mitchilli	J	▣	□	▣	▣	▣	□	▣
	L	▣	▣	▣	■	▣	□	▣
	E	▣	▣	▣	■	▣	□	▣
Hardhead catfish	A	▣	▣	▣	▣	▣	▣	▣
	S	□	□	□	□	□	□	□
Arius felis	J	▣	▣	▣	▣	▣	▣	▣
	L	□	□	□	□	▣	□	□
	E	□	□	□	□	□	□	□
Sheepshead minnow	A	▣	▣	▣	▣	▣	□	▣
	S	▣	▣	▣	▣	▣	□	▣
Cyprinodon variegatus	J	▣	▣	▣	▣	▣	□	▣
	L	▣	▣	▣	▣	▣	□	▣
	E	▣	▣	▣	▣	▣	□	▣
Gulf killifish	A	▣	□	▣	▣	▣	□	▣
	S	□	□	▣	▣	▣	□	▣
Fundulus grandis	J	▣	□	▣	▣	▣	□	▣
	L	□	□	▣	▣	▣	□	▣
	E	□	□	▣	▣	▣	□	▣
Silversides	A	▣	▣	▣	▣	▣	▣	▣
	S	□	□	□	□	□	□	□
Menidia species	J	▣	▣	▣	▣	▣	▣	▣
	L	□	□	□	□	□	□	□
	E	□	□	□	□	□	□	□

Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries						
		Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
Gizzard shad	A	▣	□	□	□	▣	▣	▣
	S	□	□	□	□	□	□	▣
Dorosoma cepedianum	J	▣	□	□	□	▣	▣	□
	L	□	□	□	□	□	□	□
	E	□	□	□	□	□	□	□
Bay anchovy	A	□	▣	▣	▣	□	▣	▣
	S	■	▣	▣	▣	□	▣	▣
Anchoa mitchilli	J	□	▣	▣	▣	□	▣	□
	L	■	▣	▣	▣	□	■	□
	E	■	▣	▣	▣	□	■	□
Hardhead catfish	A	▣	▣	▣	▣	▣	▣	▣
	S	□	□	□	□	▣	□	□
Arius felis	J	▣	▣	▣	▣	▣	▣	□
	L	□	□	□	□	▣	□	□
	E	□	□	□	□	▣	□	□
Sheepshead minnow	A	□	▣	▣	▣	▣	▣	▣
	S	□	▣	□	▣	▣	▣	□
Cyprinodon variegatus	J	□	▣	□	▣	▣	▣	□
	L	□	▣	□	▣	▣	▣	□
	E	□	▣	□	▣	▣	▣	□
Gulf killifish	A	□	▣	□	▣	□	▣	□
	S	□	▣	□	▣	□	▣	□
Fundulus grandis	J	□	▣	□	▣	□	▣	□
	L	□	▣	□	▣	□	▣	□
	E	□	▣	□	▣	□	▣	□
Silversides	A	▣	▣	▣	▣	▣	▣	■
	S	□	□	□	□	▣	□	□
Menidia species	J	▣	▣	▣	▣	▣	▣	□
	L	□	□	▣	□	▣	□	□
	E	□	□	□	□	▣	□	□
		Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
		Gulf of Mexico Estuaries						

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Lake Borgn	Lake Pontchar-train	Breton/ Chandeleur Sounds	Mississippi River	Barataria Bay	Terrebonne/ Timbalier Bays	Atchafalaya/ Vermilion Bays
		Gulf of Mexico Estuaries						
Gizzard shad	A	▣	▣	▣	□	□	□	▣
	S	▣	■	■	■	■	■	■
Dorosoma cepedianum	J	▣	▣	▣	▣	□	□	▣
	L	▣	■	■	▣	■	■	■
	E	▣	■	■	■	■	■	■
Bay anchovy	A	▣	▣	▣	▣	▣	▣	▣
	S	▣	▣	▣	▣	▣	▣	▣
Anchoa mitchilli	J	▣	▣	▣	▣	▣	▣	▣
	L	▣	▣	▣	▣	▣	▣	▣
	E	▣	▣	▣	▣	▣	▣	▣
Hardhead catfish	A	▣	▣	▣	▣	□	□	□
	S	▣	▣	▣	▣	▣	▣	□
Arius felis	J	▣	▣	▣	▣	□	□	□
	L	▣	▣	▣	▣	□	□	□
	E	▣	▣	▣	▣	□	□	□
Sheepshead minnow	A	▣	▣	□	▣	□	□	□
	S	▣	▣	□	▣	□	□	□
Cyprinodon variegatus	J	▣	▣	□	▣	□	▣	□
	L	▣	▣	□	▣	□	□	□
	E	▣	▣	□	▣	□	□	□
Gulf killifish	A	▣	▣	□	▣	▣	▣	□
	S	□	▣	□	▣	□	▣	▣
Fundulus grandis	J	▣	▣	□	▣	▣	▣	□
	L	□	▣	□	▣	□	▣	□
	E	□	▣	□	▣	□	▣	▣
Silversides	A	▣	▣	□	▣	□	□	□
	S	▣	▣	□	▣	▣	□	□
Menidia species	J	▣	▣	□	▣	□	□	□
	L	▣	▣	□	▣	▣	□	□
	E	▣	▣	□	▣	▣	□	□

Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay
		Gulf of Mexico Estuaries						
Gizzard shad	A	☐	▣	▣	☐	▣	▣	▣
	S	■	■	■	■	■	■	■
Dorosoma cepedianum	J	☐	☐	▣	☐	▣	▣	▣
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Bay anchovy	A	☐	▣	▣	☐	▣	▣	▣
	S	▣	☐	▣	☐	☐	☐	▣
Anchoa mitchilli	J	☐	▣	▣	☐	▣	▣	▣
	L	☐	☐	▣	☐	☐	☐	▣
	E	▣	☐	▣	☐	☐	☐	▣
Hardhead catfish	A	☐	▣	▣	☐	▣	▣	▣
	S	☐	▣	▣	☐	▣	▣	▣
Arius felis	J	☐	▣	▣	☐	▣	▣	▣
	L	☐	▣	▣	☐	▣	▣	▣
	E	☐	▣	▣	☐	▣	▣	▣
Sheepshead minnow	A	☐	▣	▣	☐	▣	▣	▣
	S	☐	☐	☐	☐	☐	☐	☐
Cyprinodon variegatus	J	☐	▣	▣	☐	▣	▣	▣
	L	☐	☐	☐	☐	☐	☐	☐
	E	☐	☐	☐	☐	☐	☐	☐
Gulf killifish	A	☐	▣	▣	☐	▣	▣	▣
	S	▣	▣	▣	☐	▣	▣	▣
Fundulus grandis	J	☐	▣	▣	☐	▣	▣	▣
	L	☐	▣	▣	☐	▣	▣	▣
	E	▣	▣	▣	☐	▣	▣	▣
Silversides	A	☐	▣	▣	☐	▣	▣	▣
	S	☐	☐	☐	☐	☐	☐	☐
Menidia species	J	☐	▣	▣	☐	▣	▣	▣
	L	☐	☐	☐	☐	☐	☐	☐
	E	☐	☐	☐	☐	☐	☐	☐
		Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay
		Gulf of Mexico Estuaries						

Data Reliability

■ Highly Certain

▣ Moderately Certain

☐ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay	Laguna Madre	Baffin Bay
Gizzard shad	A	▣	▣	▣
	S	■	■	■
Dorosoma cepedianum	J	▣	▣	▣
	L	■	■	■
	E	■	■	■
Bay anchovy	A	■	▣	▣
	S	▣	▣	▣
Anchoa mitchilli	J	■	▣	▣
	L	▣	▣	▣
	E	▣	▣	▣
Hardhead catfish	A	▣	▣	■
	S	▣	▣	▣
Arius felis	J	▣	▣	▣
	L	▣	▣	▣
	E	▣	▣	▣
Sheepshead minnow	A	▣	▣	▣
	S	□	□	□
Cyprinodon variegatus	J	▣	▣	▣
	L	□	▣	□
	E	□	□	□
Gulf killifish	A	▣	▣	▣
	S	▣	▣	□
Fundulus grandis	J	▣	▣	▣
	L	▣	▣	□
	E	▣	▣	□
Silversides	A	▣	▣	▣
	S	□	□	□
Menidia species	J	▣	▣	▣
	L	□	▣	□
	E	□	□	□

Corpus Christi Bay | Laguna Madre | Baffin Bay
Gulf of Mexico Estuaries

Data Reliability

- ■ Highly Certain
- ▣ Moderately Certain
- □ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Florida Bay	Ten Thousand Islands	Caloosa-hatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay
Snook *Centropomus undecimalis*	A	▣	□	□	■	▣	▣	▣
	S	▣	▣	□	▣	▣	□	■
	J	▣	▣	□	■	■	□	▣
	L	▣	□	□	□	▣	□	▣
	E	▣	▣	□	□	▣	□	■
Bluefish *Pomatomus saltatrix*	A	▣	▣	■	▣	▣	▣	□
	S	■	■	■	■	■	■	■
	J	▣	▣	■	▣	□	▣	□
	L	▣	■	■	■	■	▣	▣
	E	■	■	■	■	■	▣	■
Blue runner *Caranx crysos*	A	▣	□	□	▣	□	▣	▣
	S	■	■	□	■	■	□	■
	J	▣	□	□	▣	□	□	▣
	L	■	■	□	■	□	□	■
	E	■	■	□	■	■	□	■
Crevalle jack *Caranx hippos*	A	▣	□	□	▣	▣	□	▣
	S	■	■	□	■	▣	■	■
	J	▣	□	□	▣	▣	□	▣
	L	■	■	□	■	▣	□	▣
	E	■	■	□	■	▣	□	■
Florida pompano *Trachinotus carolinus*	A	▣	▣	■	▣	▣	▣	▣
	S	■	■	■	■	■	▣	■
	J	▣	▣	■	▣	□	▣	▣
	L	■	■	■	■	■	▣	▣
	E	■	■	■	■	■	▣	■
Gray snapper *Lutjanus griseus*	A	■	■	■	▣	■	▣	▣
	S	■	■	■	■	■	▣	■
	J	▣	▣	□	▣	▣	▣	▣
	L	■	▣	■	■	▣	▣	■
	E	■	■	■	■	■	▣	■

Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
		Gulf of Mexico Estuaries						
Snook *Centropomus undecimalis*	A	▣	■	■	■	■	■	■
	S	□	■	■	■	■	■	■
	J	□	■	■	■	■	■	■
	L	□	■	■	■	■	■	■
	E	□	■	■	■	■	■	■
Bluefish *Pomatomus saltatrix*	A	□	▣	▣	▣	▣	▣	□
	S	□	■	■	■	■	■	□
	J	□	▣	▣	▣	▣	▣	□
	L	□	■	■	■	■	■	□
	E	□	■	■	■	■	■	□
Blue runner *Caranx crysos*	A	□	▣	▣	▣	▣	▣	▣
	S	□	■	■	■	■	■	▣
	J	□	▣	▣	▣	▣	▣	▣
	L	□	■	■	■	■	■	□
	E	□	■	■	■	■	■	□
Crevalle jack *Caranx hippos*	A	□	▣	□	▣	▣	■	□
	S	□	■	■	■	■	■	□
	J	□	▣	□	▣	▣	▣	▣
	L	□	■	■	■	■	■	□
	E	□	■	■	■	■	■	□
Florida pompano *Trachinotus carolinus*	A	▣	▣	▣	▣	■	▣	□
	S	▣	■	■	■	■	■	□
	J	▣	▣	■	▣	▣	▣	▣
	L	▣	■	■	■	■	▣	□
	E	▣	■	■	■	■	▣	□
Gray snapper *Lutjanus griseus*	A	□	▣	▣	▣	■	▣	▣
	S	■	■	■	■	■	■	▣
	J	□	▣	▣	▣	▣	▣	▣
	L	▣	■	■	■	■	■	▣
	E	▣	■	■	■	■	■	▣

Apalachicola Bay | St. Andrew Bay | Choctawhatchee Bay | Pensacola Bay | Perdido Bay | Mobile Bay | Mississippi Sound
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Lake Borgn	Lake Pontchar-train	Breton/ Chandeleur Sounds	Mississippi River	Barataria Bay	Terrebonne/ Timbalier Bays	Atchafalaya/ Vermilion Bays
		Gulf of Mexico Estuaries						
Snook	A	■	■	▣	■	□	■	■
	S	■	■	■	■	□	■	■
Centropomus undecimalis	J	■	■	■	■	□	■	■
	L	■	■	■	■	□	■	■
	E	■	■	■	■	□	■	■
Bluefish	A	▣	■	■	▣	■	■	■
	S	■	■	■	■	■	■	■
Pomatomus saltatrix	J	□	■	▣	▣	▣	▣	▣
	L	■	■	■	■	□	■	■
	E	■	■	■	■	■	■	■
Blue runner	A	■	■	■	■	■	■	■
	S	■	■	■	■	■	■	■
Caranx crysos	J	■	■	□	■	▣	□	■
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Crevalle jack	A	■	■	▣	■	▣	▣	■
	S	■	■	■	■	■	■	■
Caranx hippos	J	▣	▣	▣	▣	▣	▣	□
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Florida pompano	A	■	■	▣	■	▣	□	■
	S	■	■	▣	■	■	■	■
Trachinotus carolinus	J	■	■	▣	□	▣	□	□
	L	■	■	▣	■	□	■	■
	E	■	■	▣	■	■	■	■
Gray snapper	A	■	■	■	■	■	■	■
	S	■	■	■	■	■	■	■
Lutjanus griseus	J	■	■	▣	■	▣	▣	□
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■

Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays

Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries						
		Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay
Snook	A	■	▣	▣	□	▣	▣	▣
	S	■	■	■	■	▣	■	▣
Centropomus undecimalis	J	■	▣	▣	□	▣	▣	▣
	L	■	■	▣	□	▣	▣	▣
	E	■	■	■	■	▣	■	▣
Bluefish	A	■	▣	▣	□	▣	▣	▣
	S	■	■	■	■	■	■	■
Pomatomus saltatrix	J	□	▣	▣	□	▣	▣	▣
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Blue runner	A	■	■	□	□	■	■	■
	S	■	■	■	□	■	■	■
Caranx crysos	J	■	■	□	□	■	■	■
	L	■	■	■	□	■	■	■
	E	■	■	■	□	■	■	■
Crevalle jack	A	■	▣	▣	□	□	▣	▣
	S	■	■	■	■	■	■	■
Caranx hippos	J	□	▣	▣	□	□	▣	▣
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Florida pompano	A	■	▣	▣	□	□	▣	▣
	S	■	■	■	■	■	■	■
Trachinotus carolinus	J	□	▣	▣	□	□	▣	▣
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Gray snapper	A	■	▣	▣	□	□	▣	▣
	S	■	■	■	■	■	■	■
Lutjanus griseus	J	□	▣	▣	□	□	▣	▣
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■

Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries		
		Corpus Christi Bay	Laguna Madre	Baffin Bay
Snook	A	▣	▣	▣
	S	▣	■	■
Centropomus undecimalis	J	▣	▣	▣
	L	▣	▣	▣
	E	▣	■	■
Bluefish	A	▣	▣	▣
	S	■	■	■
Pomatomus saltatrix	J	▣	▣	▣
	L	■	■	■
	E	■	■	■
Blue runner	A	■	■	■
	S	■	■	■
Caranx crysos	J	■	■	■
	L	■	■	■
	E	■	■	■
Crevalle jack	A	▣	▣	▣
	S	■	■	■
Caranx hippos	J	▣	▣	▣
	L	■	■	■
	E	■	■	■
Florida pompano	A	▣	▣	▣
	S	■	■	■
Trachinotus carolinus	J	▣	▣	▣
	L	■	■	■
	E	■	■	■
Gray snapper	A	▣	▣	▣
	S	■	■	■
Lutjanus griseus	J	▣	▣	▣
	L	■	■	■
	E	■	■	■
		Corpus Christi Bay	Laguna Madre	Baffin Bay
		Gulf of Mexico Estuaries		

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Florida Bay	Ten Thousand Islands	Caloosa-hatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay
Sheepshead	A	▣	▣	▣	▣	▣	▣	▣
	S	□	□	□	□	□	□	□
Archosargus probatocephalus	J	▣	▣	▣	▣	▣	▣	▣
	L	□	□	▣	▣	▣	□	□
	E	□	□	□	□	□	□	□
Pinfish	A	■	▣	▣	▣	■	□	▣
	S	■	■	■	■	■	■	■
Lagodon rhomboides	J	■	▣	▣	▣	■	▣	▣
	L	■	▣	■	▣	▣	▣	▣
	E	■	■	■	■	■	■	■
Silver perch	A	▣	▣	▣	▣	▣	▣	▣
	S	▣	□	□	□	□	□	□
Bairdiella chrysoura	J	■	▣	▣	▣	▣	▣	▣
	L	▣	▣	▣	▣	▣	□	□
	E	▣	□	□	□	□	□	□
Sand seatrout	A	■	▣	▣	▣	▣	□	▣
	S	■	■	□	□	▣	▣	■
Cynoscion arenarius	J	▣	▣	▣	▣	▣	▣	▣
	L	■	▣	□	□	▣	▣	■
	E	■	■	□	□	▣	■	■
Spotted seatrout	A	■	■	■	■	■	▣	▣
	S	▣	▣	▣	▣	■	▣	▣
Cynoscion nebulosus	J	■	■	■	■	■	□	▣
	L	▣	▣	▣	▣	■	▣	▣
	E	▣	▣	■	▣	▣	▣	▣
Spot	A	■	■	▣	▣	▣	□	▣
	S	■	■	■	■	▣	■	■
Leiostomus xanthurus	J	▣	▣	▣	▣	▣	▣	▣
	L	■	▣	■	▣	▣	▣	■
	E	■	■	■	■	▣	■	■

Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
		Gulf of Mexico Estuaries						
Sheepshead	A	▣	▣	▣	▣	▣	▣	▣
Archosargus probatocephalus	S	□	□	□	□	□	□	▣
	J	▣	▣	▣	▣	▣	▣	□
	L	▣	□	□	□	▣	▣	■
	E	□	□	□	□	□	□	□
Pinfish	A	▣	▣	▣	▣	▣	□	▣
Lagodon rhomboides	S	■	■	■	■	■	■	▣
	J	▣	▣	▣	▣	▣	▣	▣
	L	▣	▣	▣	▣	▣	▣	▣
	E	■	■	■	■	■	■	▣
Silver perch	A	▣	▣	▣	▣	▣	▣	□
Bairdiella chrysoura	S	□	□	□	□	▣	□	▣
	J	▣	▣	▣	▣	▣	▣	□
	L	□	□	□	□	▣	▣	□
	E	□	□	□	□	□	□	□
Sand seatrout	A	▣	▣	▣	▣	▣	▣	■
Cynoscion arenarius	S	■	▣	▣	▣	▣	▣	▣
	J	▣	▣	▣	▣	▣	▣	□
	L	▣	▣	▣	▣	▣	▣	▣
	E	■	▣	▣	□	▣	▣	▣
Spotted seatrout	A	□	▣	▣	▣	▣	▣	▣
Cynoscion nebulosus	S	▣	▣	▣	▣	▣	▣	■
	J	▣	▣	□	▣	▣	▣	■
	L	□	▣	▣	▣	▣	▣	■
	E	□	▣	▣	▣	▣	▣	▣
Spot	A	▣	▣	▣	▣	▣	▣	□
Leiostomus xanthurus	S	■	■	■	■	▣	■	▣
	J	▣	▣	▣	▣	▣	▣	□
	L	■	■	▣	▣	▣	▣	□
	E	■	■	■	■	■	■	▣
		Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
		Gulf of Mexico Estuaries						

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Lake Borgn	Lake Pontchar-train	Breton/ Chandeleur Sounds	Mississippi River	Barataria Bay	Terrebonne/ Timbalier Bays	Atchafalaya/ Vermilion Bays
Sheepshead *Archosargus probatocephalus*	A	▣	▣	▣	▣	▣	□	□
	S	■	■	□	■	□	□	■
	J	▣	▣	▣	▣	▣	□	□
	L	■	■	□	■	□	□	■
	E	■	■	□	■	□	□	■
Pinfish *Lagodon rhomboides*	A	▣	□	■	■	□	■	□
	S	■	■	■	■	▣	■	■
	J	▣	▣	▣	▣	▣	▣	□
	L	■	■	■	■	□	■	■
	E	■	■	■	■	▣	■	■
Silver perch *Bairdiella chrysoura*	A	▣	□	▣	▣	▣	▣	□
	S	□	□	□	■	□	▣	■
	J	▣	□	▣	▣	▣	▣	□
	L	□	□	□	■	□	▣	■
	E	□	□	□	■	□	▣	■
Sand seatrout *Cynoscion arenarius*	A	▣	□	▣	▣	▣	□	□
	S	□	□	□	■	□	□	■
	J	▣	□	▣	▣	▣	□	□
	L	□	□	□	■	□	□	■
	E	□	□	□	■	□	□	■
Spotted seatrout *Cynoscion nebulosus*	A	▣	▣	▣	▣	□	▣	□
	S	▣	▣	□	▣	□	▣	▣
	J	▣	▣	▣	▣	□	▣	□
	L	▣	▣	□	▣	□	▣	▣
	E	▣	▣	□	▣	□	▣	▣
Spot *Leiostomus xanthurus*	A	▣	□	□	▣	▣	□	■
	S	■	■	■	■	▣	■	■
	J	▣	▣	□	▣	▣	▣	□
	L	▣	□	■	■	▣	■	■
	E	■	■	■	■	▣	■	■

Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay
Sheepshead *Archosargus probatocephalus*	A	□	▣	▣	□	▣	▣	▣
	S	▣	▣	▣	▣	▣	▣	▣
	J	□	▣	▣	□	▣	▣	▣
	L	▣	▣	▣	▣	▣	▣	▣
	E	▣	▣	▣	▣	▣	▣	▣
Pinfish *Lagodon rhomboides*	A	□	▣	▣	□	▣	▣	▣
	S	■	■	■	■	■	■	■
	J	□	▣	▣	□	▣	▣	▣
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Silver perch *Bairdiella chrysoura*	A	□	▣	▣	□	▣	▣	▣
	S	■	▣	▣	□	▣	▣	▣
	J	□	▣	▣	□	▣	▣	▣
	L	■	▣	▣	□	▣	▣	▣
	E	■	▣	▣	□	▣	▣	▣
Sand seatrout *Cynoscion arenarius*	A	□	▣	▣	□	▣	▣	▣
	S	■	□	□	□	□	□	□
	J	□	▣	▣	□	▣	▣	▣
	L	■	□	□	□	□	□	□
	E	■	□	□	□	□	□	□
Spotted seatrout *Cynoscion nebulosus*	A	□	▣	▣	□	▣	▣	▣
	S	▣	□	▣	□	□	▣	▣
	J	□	▣	▣	□	▣	▣	▣
	L	▣	▣	▣	□	□	▣	▣
	E	▣	□	▣	□	□	▣	▣
Spot *Leiostomus xanthurus*	A	■	▣	▣	□	▣	▣	▣
	S	■	■	▣	■	▣	▣	▣
	J	□	▣	▣	□	▣	▣	▣
	L	■	■	▣	■	▣	▣	▣
	E	■	■	▣	■	▣	▣	▣

Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain
▣ Moderately Certain
□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay	Laguna Madre	Baffin Bay
Sheepshead *Archosargus probatocephalus*	A	▣	▣	▣
	S	▣	▣	▣
	J	▣	▣	▣
	L	▣	▣	▣
	E	▣	▣	▣
Pinfish *Lagodon rhomboides*	A	▣	▣	▣
	S	■	■	■
	J	▣	▣	▣
	L	■	■	■
	E	■	■	■
Silver perch *Bairdiella chrysoura*	A	▣	▣	▣
	S	▣	▣	▣
	J	▣	▣	▣
	L	▣	▣	▣
	E	▣	▣	▣
Sand seatrout *Cynoscion arenarius*	A	▣	▣	▣
	S	□	□	□
	J	▣	▣	▣
	L	□	□	□
	E	□	□	□
Spotted seatrout *Cynoscion nebulosus*	A	▣	▣	▣
	S	▣	▣	▣
	J	▣	▣	▣
	L	▣	▣	▣
	E	▣	▣	▣
Spot *Leiostomus xanthurus*	A	▣	▣	▣
	S	▣	▣	▣
	J	▣	▣	▣
	L	▣	▣	▣
	E	▣	▣	▣

Corpus Christi Bay | Laguna Madre | Baffin Bay
Gulf of Mexico Estuaries

Data Reliability

- ■ Highly Certain
- ▣ Moderately Certain
- □ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Florida Bay	Ten Thousand Islands	Caloosa-hatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay
		Gulf of Mexico Estuaries						
Atlantic croaker *Micropogonias undulatus*	A	■	■	■	■	■	□	▣
	S	■	■	■	■	□	■	■
	J	■	▣	▣	▣	▣	□	▣
	L	■	▣	■	■	■	□	▣
	E	■	■	■	■	■	■	■
Black drum *Pogonias cromis*	A	▣	▣	▣	▣	■	▣	▣
	S	▣	□	□	□	■	□	□
	J	▣	▣	▣	▣	■	▣	▣
	L	□	▣	▣	▣	▣	□	□
	E	□	□	□	□	□	□	□
Red drum *Sciaenops ocellatus*	A	▣	▣	▣	▣	▣	□	▣
	S	▣	▣	■	▣	■	□	▣
	J	▣	▣	■	▣	■	□	▣
	L	▣	▣	▣	▣	▣	□	▣
	E	▣	▣	■	▣	▣	□	▣
Striped mullet *Mugil cephalus*	A	▣	▣	▣	▣	▣	□	▣
	S	▣	■	■	■	■	■	■
	J	▣	▣	▣	▣	▣	□	▣
	L	▣	■	■	▣	■	▣	▣
	E	▣	■	■	■	■	■	■
Code goby *Gobiosoma robustum*	A	□	▣	▣	□	▣	□	▣
	S	▣	▣	▣	□	▣	□	▣
	J	▣	▣	▣	□	▣	□	▣
	L	▣	▣	▣	□	□	□	▣
	E	▣	▣	▣	□	▣	□	▣
Spanish mackerel *Scomberomorus maculatus*	A	▣	■	▣	□	■	□	▣
	S	■	■	■	■	■	■	■
	J	▣	▣	▣	□	▣	□	▣
	L	■	■	■	■	■	■	■
	E	■	■	■	■	□	■	■

Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries						
		Apalachicola Bay	St. Andrew Bay	Choctawhatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
Atlantic croaker *Micropogonias undulatus*	A	▣	▣	▣	▣	■	▣	▣
	S	■	■	■	■	■	■	▣
	J	▣	▣	▣	▣	■	▣	□
	L	▣	▣	▣	▣	■	▣	▣
	E	■	□	■	■	■	■	□
Black drum *Pogonias cromis*	A	▣	▣	▣	▣	▣	▣	□
	S	□	□	□	□	□	□	▣
	J	▣	▣	▣	▣	▣	▣	▣
	L	□	□	□	□	▣	▣	▣
	E	□	□	□	□	□	□	▣
Red drum *Sciaenops ocellatus*	A	▣	▣	□	▣	▣	▣	□
	S	▣	■	□	■	▣	▣	▣
	J	▣	▣	□	▣	▣	▣	□
	L	▣	▣	□	▣	▣	▣	▣
	E	▣	▣	□	▣	▣	▣	▣
Striped mullet *Mugil cephalus*	A	▣	▣	▣	▣	▣	▣	■
	S	■	■	■	■	■	■	▣
	J	▣	▣	▣	▣	▣	▣	■
	L	▣	▣	▣	▣	▣	▣	▣
	E	■	■	■	■	■	■	▣
Code goby *Gobiosoma robustum*	A	▣	▣	▣	▣	▣	■	▣
	S	▣	▣	▣	▣	▣	■	▣
	J	▣	▣	▣	▣	▣	■	▣
	L	▣	▣	▣	▣	▣	■	▣
	E	▣	▣	▣	▣	▣	■	▣
Spanish mackerel *Scomberomorus maculatus*	A	□	□	▣	▣	▣	▣	□
	S	■	■	■	■	■	■	□
	J	□	□	▣	▣	▣	▣	□
	L	■	■	■	■	■	■	□
	E	■	■	■	■	■	■	□

Apalachicola Bay | St. Andrew Bay | Choctawhatchee Bay | Pensacola Bay | Perdido Bay | Mobile Bay | Mississippi Sound
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Lake Borgn	Lake Pontchar-train	Breton/ Chandeleur Sounds	Mississippi River	Barataria Bay	Terrebonne/ Timbalier Bays	Atchafalaya/ Vermilion Bays
		Gulf of Mexico Estuaries						
Atlantic croaker	A	▣	□	□	■	▣	■	■
	S	■	■	■	■	▣	■	■
Micropogonias undulatus	J	▣	▣	□	□	▣	▣	□
	L	▣	■	■	■	▣	▣	▣
	E	■	■	■	■	▣	■	■
Black drum	A	▣	▣	▣	▣	■	▣	□
	S	■	■	□	■	□	▣	■
Pogonias cromis	J	▣	▣	□	▣	■	▣	□
	L	▣	■	□	■	□	▣	■
	E	■	■	□	■	□	▣	■
Red drum	A	▣	■	▣	▣	□	□	□
	S	■	■	□	■	□	■	■
Sciaenops ocellatus	J	▣	▣	▣	▣	□	▣	□
	L	■	■	□	■	▣	■	■
	E	■	■	□	■	□	■	■
Striped mullet	A	▣	□	□	▣	□	□	□
	S	■	■	■	■	■	■	■
Mugil cephalus	J	▣	▣	□	□	□	□	□
	L	▣	■	■	■	□	■	■
	E	■	■	■	■	■	■	■
Code goby	A	▣	□	□	■	□	■	□
	S	□	□	□	■	□	■	□
Gobiosoma robustum	J	▣	□	□	■	□	■	□
	L	□	□	□	■	□	■	□
	E	□	□	□	■	□	■	□
Spanish mackerel	A	■	■	▣	■	▣	▣	■
	S	■	■	■	■	■	■	■
Scomberomorus maculatus	J	▣	▣	▣	▣	□	▣	□
	L	■	■	■	■	▣	■	■
	E	■	■	■	■	■	■	■

Lake Borgn | Lake Pontchar-train | Breton/ Chandeleur Sounds | Mississippi River | Barataria Bay | Terrebonne/ Timbalier Bays | Atchafalaya/ Vermilion Bays
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay
		Gulf of Mexico Estuaries						
Atlantic croaker *Micropogonias undulatus*	A	■	▣	▣	□	▣	▣	▣
	S	■	■	■	■	■	■	■
	J	□	▣	▣	□	▣	▣	▣
	L	■	■	▣	■	▣	▣	▣
	E	■	■	■	■	■	■	■
Black drum *Pogonias cromis*	A	□	□	▣	□	▣	▣	▣
	S	■	■	▣	■	▣	▣	▣
	J	□	▣	▣	□	▣	▣	▣
	L	■	■	▣	■	▣	▣	▣
	E	■	■	▣	■	▣	▣	▣
Red drum *Sciaenops ocellatus*	A	□	▣	▣	□	▣	▣	▣
	S	■	■	□	■	□	□	□
	J	□	▣	▣	□	▣	▣	▣
	L	■	■	▣	■	▣	▣	▣
	E	■	■	□	■	□	□	□
Striped mullet *Mugil cephalus*	A	□	▣	▣	□	▣	▣	▣
	S	■	■	▣	■	▣	▣	▣
	J	□	▣	▣	□	▣	▣	▣
	L	■	■	▣	■	▣	▣	▣
	E	■	■	▣	■	▣	▣	▣
Code goby *Gobiosoma robustum*	A	▣	▣	▣	□	□	□	▣
	S	▣	▣	▣	□	□	□	▣
	J	▣	▣	▣	□	□	□	▣
	L	▣	▣	▣	□	□	□	▣
	E	▣	▣	▣	□	□	□	▣
Spanish mackerel *Scomberomorus maculatus*	A	■	□	▣	□	□	▣	▣
	S	■	■	■	■	■	■	■
	J	□	□	▣	□	□	▣	▣
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■

Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Data Reliability

- ■ Highly Certain
- ▣ Moderately Certain
- □ Reasonable Inference

Life Stage

- A - Adults
- S - Spawning adults
- J - Juveniles
- L - Larvae
- E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries		
		Corpus Christi Bay	Laguna Madre	Baffin Bay
Atlantic croaker *Micropogonias undulatus*	A	▣	▣	▣
	S	■	■	■
	J	▣	▣	▣
	L	▣	▣	▣
	E	■	■	■
Black drum *Pogonias cromis*	A	▣	▣	▣
	S	▣	▣	▣
	J	▣	▣	▣
	L	▣	□	▣
	E	▣	□	▣
Red drum *Sciaenops ocellatus*	A	▣	▣	▣
	S	□	□	■
	J	▣	▣	▣
	L	▣	▣	▣
	E	□	□	■
Striped mullet *Mugil cephalus*	A	▣	▣	▣
	S	▣	▣	▣
	J	▣	▣	▣
	L	▣	▣	▣
	E	▣	▣	▣
Code goby *Gobiosoma robustum*	A	▣	□	▣
	S	▣	□	□
	J	▣	▣	▣
	L	▣	□	□
	E	▣	□	□
Spanish mackerel *Scomberomorus maculatus*	A	▣	□	▣
	S	■	■	■
	J	▣	▣	▣
	L	■	■	■
	E	■	■	■
		Corpus Christi Bay	Laguna Madre	Baffin Bay
		Gulf of Mexico Estuaries		

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Florida Bay	Ten Thousand Islands	Caloosa-hatchee River	Charlotte Harbor	Tampa Bay	Suwannee River	Apalachee Bay
Gulf flounder	A	▣	▣	▣	▣	▣	□	□
	S	■	■	■	■	■	■	■
Paralichthys albigutta	J	▣	▣	▣	▣	▣	□	▣
	L	▣	▣	■	▣	▣	□	▣
	E	■	■	■	■	■	■	■
Southern flounder	A	□	■	■	□	□	▣	▣
	S	■	■	■	■	■	■	■
Parlichthys lethostigma	J	□	■	■	□	□	▣	▣
	L	■	■	■	□	□	■	▣
	E	■	■	■	■	□	■	■

Florida Bay | Ten Thousand Islands | Caloosa-hatchee River | Charlotte Harbor | Tampa Bay | Suwannee River | Apalachee Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries						
		Apalachi-cola Bay	St. Andrew Bay	Choctaw-hatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
Gulf flounder	A	□	▣	▣	▣	▣	▣	▣
	S	■	■	■	■	■	■	▣
Paralichthys albigutta	J	□	▣	▣	▣	▣	▣	▣
	L	□	▣	▣	▣	▣	▣	□
	E	■	■	■	■	■	■	□
Southern flounder	A	□	▣	▣	▣	▣	▣	□
	S	■	■	■	■	■	■	▣
Parlichthys lethostigma	J	□	▣	▣	▣	▣	▣	□
	L	▣	▣	▣	▣	▣	▣	□
	E	■	■	■	■	■	■	▣
		Apalachi-cola Bay	St. Andrew Bay	Choctaw-hatchee Bay	Pensacola Bay	Perdido Bay	Mobile Bay	Mississippi Sound
		Gulf of Mexico Estuaries						

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Lake Borgn	Lake Pontchar-train	Breton/ Chandeleur Sounds	Mississippi River	Barataria Bay	Terrebonne/ Timbalier Bays	Atchafalaya/ Vermilion Bays
		Gulf of Mexico Estuaries						
Gulf flounder *Paralichthys albigutta*	A	■	■	■	■	■	■	■
	S	■	■	■	■	■	■	■
	J	■	■	■	■	■	■	■
	L	■	■	■	■	■	■	■
	E	■	■	■	■	■	■	■
Southern flounder *Parlichthys lethostigma*	A	▣	□	▣	▣	▣	□	□
	S	■	■	■	■	□	■	■
	J	▣	▣	▣	▣	▣	□	□
	L	■	■	■	■	□	■	■
	E	■	■	■	■	□	■	■
		Lake Borgn	Lake Pontchar-train	Breton/ Chandeleur Sounds	Mississippi River	Barataria Bay	Terrebonne/ Timbalier Bays	Atchafalaya/ Vermilion Bays
		Gulf of Mexico Estuaries						

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries						
		Calcasieu Lake	Sabine Lake	Galveston Bay	Brazos River	Matagorda Bay	San Antonio Bay	Aransas Bay
Gulf flounder	A	■	▣	▣	□	▣	▣	▣
	S	■	■	■	■	■	■	■
Paralichthys albigutta	J	■	▣	▣	□	▣	▣	▣
	L	■	■	▣	■	■	▣	▣
	E	■	■	■	■	■	■	■
Southern flounder	A	□	▣	▣	□	▣	▣	▣
	S	■	■	▣	■	▣	▣	▣
Parlichthys lethostigma	J	□	▣	▣	□	▣	▣	▣
	L	■	■	▣	■	▣	▣	▣
	E	■	■	▣	■	▣	▣	▣

Calcasieu Lake | Sabine Lake | Galveston Bay | Brazos River | Matagorda Bay | San Antonio Bay | Aransas Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

□ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Table 6, continued. Data reliability

Species/Life Stage		Gulf of Mexico Estuaries: Corpus Christi Bay	Gulf of Mexico Estuaries: Laguna Madre	Gulf of Mexico Estuaries: Baffin Bay
Gulf flounder *Paralichthys albigutta*	A	▣	▣	▣
	S	■	■	■
	J	▣	▣	▣
	L	▣	▣	▣
	E	■	■	■
Southern flounder *Parlichthys lethostigma*	A	▣	▣	▣
	S	▣	▣	▣
	J	▣	▣	▣
	L	▣	▣	▣
	E	▣	▣	▣

Corpus Christi Bay | Laguna Madre | Baffin Bay
Gulf of Mexico Estuaries

Data Reliability

■ Highly Certain

▣ Moderately Certain

☐ Reasonable Inference

Life Stage

A - Adults
S - Spawning adults
J - Juveniles
L - Larvae
E - Eggs

Appendices

National Estuarine Atlas

PHYSICAL AND HYDROLOGIC CHARACTERISTICS

PHYSICAL

Surface Areas (mi^2)	
Fluvial Drainage	39,725
Estuarine Drainage	4,875
Estuarine Zones	
Tidal Fresh	29
Mixing Zone	327
Seawater	53
Total	409
Dimensions	
Length (mi.)	128.0
Width (mi.): Average	13.6
Minimum	8.0
Maximum	23.6
Average Depth (ft.)	9.6
Average Depth to Width Ratio	1.3×10^{-4}
Stratification Classification	
3-Month High Flow	HS
3-Month Low Flow	MS

FRESHWATER INFLOW

Flow Rates (1000 cfs)		
Period of Record	1975-1982	
Long Term Average Daily	79.3	
Long Term Average Monthly	J 129.8	J 32.3
	F 120.7	A 29.4
	M 161.4	S 29.9
	A 179.4	O 36.9
	M 83.3	N 43.4
	J 44.5	D 64.0
7-Day, 10-Year Low Flow	7.6	
50-Year Flood	595.7	
100-Year Flood	653.0	
Flow Ratios		
Average Annual	0.449	
High Flow Period	0.870	
Low Flow Period	0.173	

TIDAL DATA

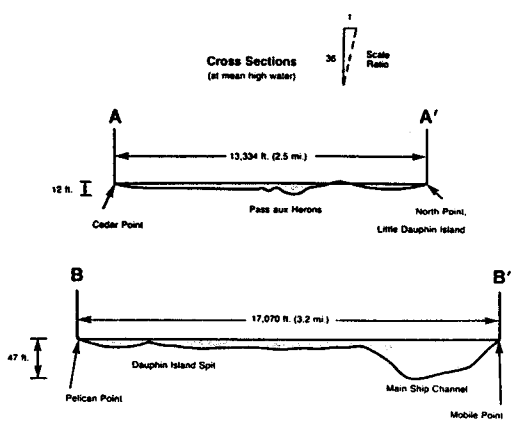
Prevailing Tide: Diurnal

Tidal Prism (cf): 1.58×10^{10}

Phase Range of Tide (ft.)

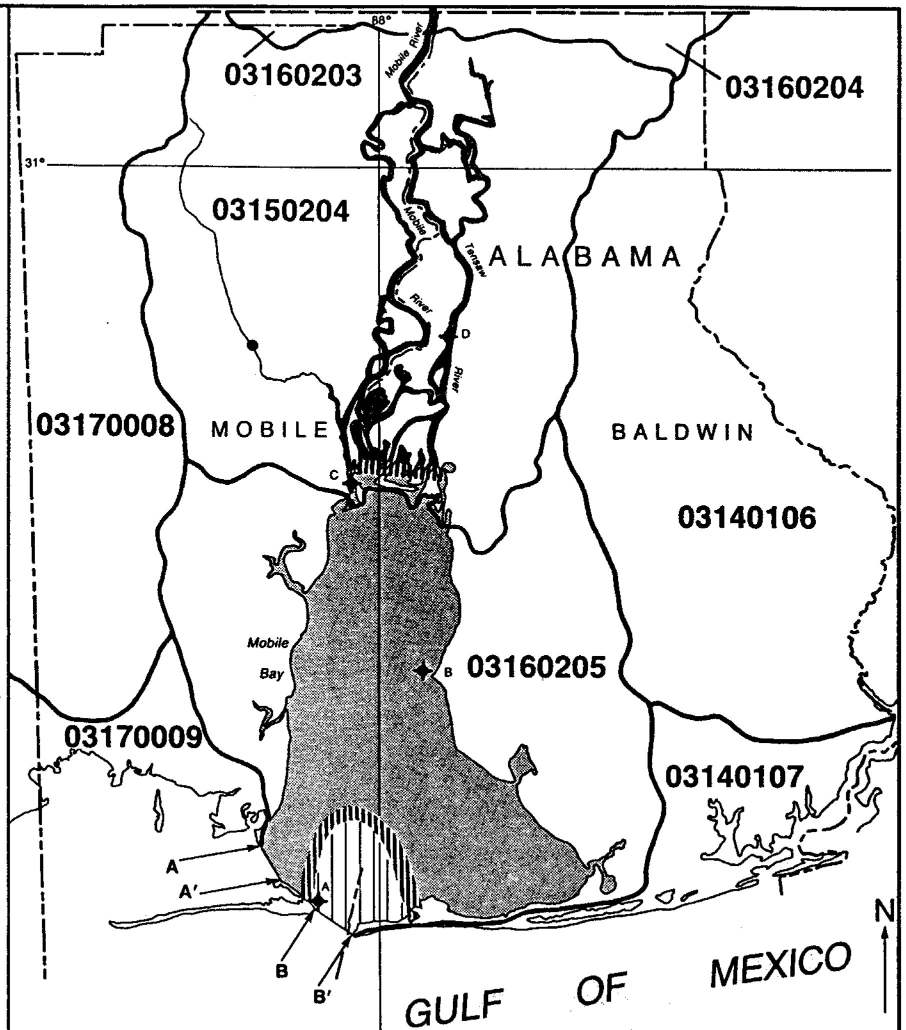
Map Key	Station	Range
A	3194	1.3
B	3197	1.4
C	3196	1.4
D	3199	0.6

Abbreviations: Vertically Homogeneous, VH; Moderately Stratified, MS; Highly Stratified, HS.



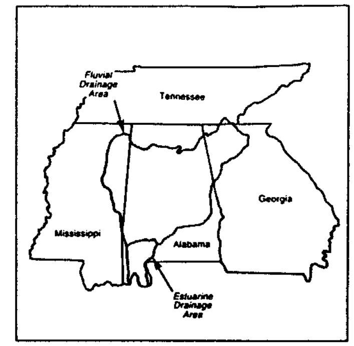
Notes:
Approximately 40% of Estuarine Drainage Area is shown on map.

References:
April, et al., 1976. April and Rancey, 1979. Bault, 1972. Bingham, 1982. Crane, 1971. Haines, 1973. Ling, 1981. Olin and Bingham, 1977. Rollins, et al., 1983. Schroeder, 1977. Schroeder, 1979. Schroeder and Lysinger, 1979. U.S. Department of Commerce, 1983a.



Map Sources:
U.S. Geological Survey, State of Alabama, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 11376, February 1984, scale 1:80,000.

Mobile Bay
AL



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Strategic Assessment Branch
Ocean Assessments Division
Office of Oceanography and Marine Assessment
National Ocean Service / NOAA

3.11

Appendix 2. Table of references and personal communications

Species	Florida Bay, FL
Bay scallop *Argopecten irradians*	28 Fonseca, LaCroix, Tilmant
American oyster *Crassostrea virginica*	Tilmant
Common rangia *Rangia cuneata*	491 Marelli, Tilmant
Hard clam *Mercenaria species*	296, 297, 429 Tilmant
Bay squid *Lolliguncula brevis*	56, 429, 630, 780, 878 Schmidt
Brown shrimp *Peneaus aztecus*	11, 658, 692
Pink shrimp *Peneaus duorarum*	11, 64, 105, 295, 429, 458, 658, 692, 748, 749, 782, 878 Schmidt, Tilmant
White shrimp *Penaeus setiferus*	658, 692 Tilmant
Grass shrimp *Palaemonetes pugio*	16, 782, 962 Tilmant
Spiny lobster *Panulirus argus*	200, 309, 429, 433, 438, 535, 560, 561, 547, 658, 868 Hunt, Tilmant
Blue crab *Callinectes sapidus*	392, 429, 892, 898, 962 Steele, Tilmant
Gulf stone crab *Menippe adina*	947
Stone crab *Menippe mercenaria*	61, 106, 226, 241, 242, 429, 511, 658, 898, 946, 947 Bert
Bull shark *Carcharhinus leucas*	429, 714, 780, 878 Schmidt
Tarpon *Megalops atlanticus*	460, 524, 780, 898
Alabama shad *Alosa alabamae*	909 Tilmant
Gulf menhaden *Brevoortia patronus*	780, 879, 909 Schmidt, Tilmant
Yellowfin menhaden *Brevoortia smithii*	152, 162, 524, 780, 892, 909 Tilmant
Gizzard shad *Dorosoma cepedianum*	460, 504, 524
Bay anchovy *Anchoa mitchilli*	460, 524, 750, 780, 832, 878, 879, 890, 892 Tilmant
Hardhead catfish *Arius felis*	56, 429, 524, 645, 714, 753, 780, 832, 833, 878, 879, 891, 898 Schmidt
Sheepshead minow *Cyprinodon variegatus*	524, 718, 780, 831, 832, 878, 879, 892 Tilmant
Gulf killifish *Fundulus grandis*	235, 306, 429, 524, 718, 831, 878, 891 Tilmant
Silversides *Menidia species*	524, 753, 780, 831, 878, 879, 891 Schmidt
Snook *Centropomus undecemalis*	429, 504, 524, 714, 715, 780, 897, 899, 898, 901
Bluefish *Pomatomus saltatrix*	342, 539, 779, 780
Blue runner *Caranx crysos*	301, 302, 429, 753, 779, 780, 841, 877 Edwards, Tilmant
Crevalle jack *Caranx hippos*	429, 524, 753, 779, 780, 832, 841, 877, 898 Edwards
Florida pompano *Trachinotus carolinus*	290, 658, 780, 892, 898 Tilmant
Gray snapper *Lutjanus griseus*	70, 114, 131, 312, 386, 429, 524, 714, 715, 773, 771, 772, 780, 832, 833, 879, 891, 892, 890, 898, 962 Powell, Thayer, Tilmant
Sheepshead *Archosargus probatocephalus*	56, 114, 219, 429, 445, 524, 714, 753, 780, 831, 878, 877, 879, 891, 890, 898 Schmidt
Pinfish *Lagodon rhomboides*	429, 524, 780, 782, 832, 833, 879, 890, 962 Hettler, Powell, Tilmant
Silver perch *Bairdiella chysoura*	219, 524, 714, 780, 831, 832, 833, 878, 879, 891, 890 Schmidt
Sand seatrout *Cynoscion arenarius*	218, 443, 658, 782, 863, 879, 891 Tilmant
Spotted seatrout *Cynoscion nebulosus*	114, 131, 219, 386, 429, 446, 697, 714, 715, 773, 774, 780, 832, 879, 892, 890, 899, 898, 937
Spot *Leiostomus xanthurus*	443, 658, 782, 879, 891, 892, 962 Tilmant
Atlantic croaker *Micropogonias undulatus*	443, 780, 843 Davis, Schmidt
Black drum *Pogonias cromis*	56, 114, 162, 443, 714, 753, 780, 878, 879, 891, 898 Schmidt
Red drum *Sciaenops ocellatus*	114, 429, 524, 658, 714, 715, 780, 831, 879, 899, 900, 898, 957 Schmidt, Tilmant
Striped mullet *Mugil cephalus*	278, 429, 524, 780, 832, 833, 878, 892, 898 Hettler, Powell, Tilmant
Code goby *Gobiosoma robustum*	429, 524, 780, 782, 878, 879, 892, 962 Tilmant
Spanish mackerel *Scomberomorus maculatus*	263, 475, 483, 780, 898
Gulf flounder *Paralichthys albigutta*	753, 780, 832, 879, 892 Powell, Tilmant
Southern flounder *Paralicthys lethostigma*	291, 658, 780 Tilmant

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Ten Thousand Islands, FL
Bay scallop *Argopecten irradians*	28
American oyster *Crassostrea virginica*	118, 123, 658, 782, 845 Browder, Thoemke
Common rangia *Rangia cuneata*	106, 491 Browder, Marelli, Tilmant
Hard clam *Mercenaria species*	106, 297, 936 Browder, Tashiro, Tilmant
Bay squid *Lolliguncula brevis*	56, 104, 106, 161, 199, 509, 878, 781 Schmidt
Brown shrimp *Peneaus aztecus*	332, 658, 692, 946
Pink shrimp *Peneaus duorarum*	64, 105, 123, 226, 295, 648, 658, 692, 754, 782, 876 Browder, Tilmant, Schmidt
White shrimp *Penaeus setiferus*	106, 658, 692 Browder, Tilmant
Grass shrimp *Palaemonetes pugio*	16, 106, 123, 161, 226, 946, 962 Browder, Tilmant
Spiny lobster *Panulirus argus*	106, 161, 547, 561, 658 Hunt
Blue crab *Callinectes sapidus*	106, 123, 161, 392, 602, 898 Browder, Steele
Gulf stone crab *Menippe adina*	947
Stone crab *Menippe mercenaria*	62, 63, 106, 123, 226, 511, 658, 898, 946, 947 Bert, Browder
Bull shark *Carcharhinus leucas*	77, 123, 157, 660, 781, 829 Schmidt
Tarpon *Megalops atlanticus*	103, 106, 123, 161, 524, 658, 898
Alabama shad *Alosa alabamae*	909
Gulf menhaden *Brevoortia patronus*	106, 123, 161, 879, 909 Schmidt
Yellowfin menhaden *Brevoortia smithii*	106, 107, 123, 152, 161, 162, 909 Browder
Gizzard shad *Dorosoma cepedianum*	460, 504, 524 Schmidt
Bay anchovy *Anchoa mitchilli*	106, 123, 161, 524, 750, 878, 879 Browder
Hardhead catfish *Arius felis*	56, 106, 123, 158, 199, 226, 509, 524, 645, 660, 781, 879, 898 Schmidt
Sheepshead minow *Cyprinodon variegatus*	103, 106, 107, 123, 161, 524, 878, 879 Browder
Gulf killifish *Fundulus grandis*	103, 106, 107, 123, 161, 235, 524 Browder
Silversides *Menidia species*	103, 107, 123, 161, 509, 524, 660, 878, 879 Schmidt
Snook *Centropomus undecemalis*	103, 123, 269, 504, 524, 794, 897, 898, 899, 901, 903 Browder
Bluefish *Pomatomus saltatrix*	106, 269, 342, 539, 658
Blue runner *Caranx crysos*	106, 107, 301, 302, 509, 878 Edwards
Crevalle jack *Caranx hippos*	106, 107, 123, 161, 509, 524, 590, 878, 898 Browder
Florida pompano *Trachinotus carolinus*	106, 161, 658, 898
Gray snapper *Lutjanus griseus*	70, 123, 161, 312, 504, 524, 770, 771, 878, 879, 898 Browder, Tilmant
Sheepshead *Archosargus probatocephalus*	56, 106, 107, 123, 158, 161, 162, 219, 445, 509, 524, 660, 878, 879, 898 Schmidt
Pinfish *Lagodon rhomboides*	Bro86, 123, 162, 161, 524, 643, 782, 879
Silver perch *Bairdiella chysoura*	106, 108, 107, 123, 158, 161, 162, 219, 443, 509, 524, 660, 753, 781, 878, 879 Schmidt
Sand seatrout *Cynoscion arenarius*	106, 107, 123, 161, 218, 808, 863, 879 Browder
Spotted seatrout *Cynoscion nebulosus*	123, 161, 219, 690, 697, 774, 879, 898, 899 Browder
Spot *Leiostomus xanthurus*	106, 107, 123, 161, 443, 878, 879 Browder, Tilmant
Atlantic croaker *Micropogonias undulatus*	106, 161, 878 Browder, Tilmant
Black drum *Pogonias cromis*	56, 106, 123, 161, 162, 443, 509, 878, 879, 898 Schmidt
Red drum *Sciaenops ocellatus*	106, 123, 158, 162, 443, 524, 714, 770, 879, 898, 899, 900 Browder, Schmidt
Striped mullet *Mugil cephalus*	78, 103, 106, 123, 161, 278, 509, 524, 878, 898 Browder, Hettler, Tilmant
Code goby *Gobiosoma robustum*	106, 107, 123, 158, 161, 524, 878, 879 Browder
Spanish mackerel *Scomberomorus maculatus*	123, 263, 298, 475, 483, 694, 898 Browder
Gulf flounder *Paralichthys albigutta*	107, 123, 161, 879 Browder
Southern flounder *Paralicthys lethostigma*	106, 107, 123, 291, 658 Browder

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Caloosahatchee River, FL
Bay scallop *Argopecten irradians*	28 Estevez
American oyster *Crassostrea virginica*	118, 658 Chamberlain
Common rangia *Rangia cuneata*	297, 491 Marelli
Hard clam *Mercenaria species*	297, 491, 509, 525 Chamberlain
Bay squid *Lolliguncula brevis*	56, 224 Fraser
Brown shrimp *Peneaus aztecus*	658, 692, 946
Pink shrimp *Peneaus duorarum*	295, 333, 658, 692
White shrimp *Penaeus setiferus*	658, 692
Grass shrimp *Palaemonetes pugio*	16, 333 Chamberlain
Spiny lobster *Panulirus argus*	547 Hunt
Blue crab *Callinectes sapidus*	602, 910 Chamberlain, Steele
Gulf stone crab *Menippe adina*	947
Stone crab *Menippe mercenaria*	62, 63, 226, 511, 658, 947 Bert
Bull shark *Carcharhinus leucas*	77, 157, 829 Fraser, Heuter
Tarpon *Megalops atlanticus*	Fraser
Alabama shad *Alosa alabamae*	909
Gulf menhaden *Brevoortia patronus*	909
Yellowfin menhaden *Brevoortia smithii*	152, 333, 909, 928 Chamberlain
Gizzard shad *Dorosoma cepedianum*	460, 504 Fraser
Bay anchovy *Anchoa mitchilli*	226, 333 Chamberlain, Fraser
Hardhead catfish *Arius felis*	56, 226, 246, 333, 645, 709, 928 Fraser
Sheepshead minow *Cyprinodon variegatus*	333, 388, 709, 730 Chamberlain, Fraser
Gulf killifish *Fundulus grandis*	333 Chamberlain
Silversides *Menidia species*	226, 246, 333, 709, 928 Fraser
Snook *Centropomus undecemalis*	333, 504, 542, 923 Chamberlain, Fraser
Bluefish *Pomatomus saltatrix*	333, 342, 539, 658, 709, 928 Chamberlain
Blue runner *Caranx crysos*	928 Chamberlain
Crevalle jack *Caranx hippos*	333, 709 Chamberlain
Florida pompano *Trachinotus carolinus*	333, 709, 843, 928 Chamberlain
Gray snapper *Lutjanus griseus*	333, 928 Chamberlain, Fraser
Sheepshead *Archosargus probatocephalus*	56, 219, 246, 333, 445 Fraser
Pinfish *Lagodon rhomboides*	333, 643, 843, 928 Chamberlain
Silver perch *Bairdiella chysoura*	219, 226, 246, 333, 709, 928 Fraser
Sand seatrout *Cynoscion arenarius*	218, 333 Chamberlain, Fraser
Spotted seatrout *Cynoscion nebulosus*	161, 219, 226, 246,114, 697, 928 Fraser, Chamberlain
Spot *Leiostomus xanthurus*	333, 928 Chamberlain, Fraser
Atlantic croaker *Micropogonias undulatus*	333, 928 Chamberlain
Black drum *Pogonias cromis*	56, 333, 928 Fraser
Red drum *Sciaenops ocellatus*	333, 843 Chamberlain, Fraser
Striped mullet *Mugil cephalus*	78, 333, 658, 896, 928 Chamberlain, Fraser
Code goby *Gobiosoma robustum*	79, 274, 333, 843, 928 Chamberlain
Spanish mackerel *Scomberomorus maculatus*	298, 694, 709 Chamberlain
Gulf flounder *Paralichthys albigutta*	333 Chamberlain
Southern flounder *Paralicthys lethostigma*	333 Chamberlain

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Charlotte Harbor, FL
Bay scallop *Argopecten irradians*	28 Estevez
American oyster *Crassostrea virginica*	118, 658 Fraser
Common rangia *Rangia cuneata*	297, 491 Estevez, Marelli
Hard clam *Mercenaria species*	297, 459, 491, 509, 525 Fraser
Bay squid *Lolliguncula brevis*	56, 224 Fraser
Brown shrimp *Peneaus aztecus*	658, 692, 946
Pink shrimp *Peneaus duorarum*	658, 692 Browder
White shrimp *Penaeus setiferus*	658, 692
Grass shrimp *Palaemonetes pugio*	16, 333
Spiny lobster *Panulirus argus*	547, 658 Fraser, Hunt
Blue crab *Callinectes sapidus*	226, 333, 392, 602, 910 Fraser, Steele
Gulf stone crab *Menippe adina*	947
Stone crab *Menippe mercenaria*	62, 63, 226, 511, 658, 947 Bert
Bull shark *Carcharhinus leucas*	77, 157, 246, 829 Fraser, Heuter
Tarpon *Megalops atlanticus*	219, 460, 827 Fraser
Alabama shad *Alosa alabamae*	909
Gulf menhaden *Brevoortia patronus*	909
Yellowfin menhaden *Brevoortia smithii*	152, 333, 909, 928 Fraser
Gizzard shad *Dorosoma cepedianum*	460, 504 Fraser
Bay anchovy *Anchoa mitchilli*	226, 246, 333, 928
Hardhead catfish *Arius felis*	56, 226, 246, 333, 645, 709, 928 Fraser
Sheepshead minow *Cyprinodon variegatus*	333, 719, 928 Fraser
Gulf killifish *Fundulus grandis*	246, 928 Fraser
Silversides *Menidia species*	226, 246, 333, 709, 928 Fraser
Snook *Centropomus undecemalis*	504, 928 Browder, Fraser
Bluefish *Pomatomus saltatrix*	342, 539, 658, 928
Blue runner *Caranx crysos*	928 Fraser
Crevalle jack *Caranx hippos*	333, 509, 928 Fraser
Florida pompano *Trachinotus carolinus*	333, 843, 928 Fraser
Gray snapper *Lutjanus griseus*	333, 928 Fraser
Sheepshead *Archosargus probatocephalus*	56, 219, 246, 333, 445 Fraser
Pinfish *Lagodon rhomboides*	219, 226, 643, 928
Silver perch *Bairdiella chysoura*	219, 226, 246, 333, 709, 928 Fraser
Sand seatrout *Cynoscion arenarius*	218, 219, 333, 658, 928 Fraser
Spotted seatrout *Cynoscion nebulosus*	161, 219, 226, 246, 446, 697, 928 Fraser
Spot *Leiostomus xanthurus*	333, 658, 928 Fraser
Atlantic croaker *Micropogonias undulatus*	928
Black drum *Pogonias cromis*	56, 333, 928 Fraser
Red drum *Sciaenops ocellatus*	333, 928 Fraser
Striped mullet *Mugil cephalus*	78, 333, 658, 896, 928 Fraser
Code goby *Gobiosoma robustum*	246, 274, 843, 928 Fraser
Spanish mackerel *Scomberomorus maculatus*	298, 475, 483, 928
Gulf flounder *Paralichthys albigutta*	219, 928 Fraser
Southern flounder *Paralicthys lethostigma*	219, 928 Fraser

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Tampa Bay, FL
Bay scallop *Argopecten irradians*	28, 508 Fonseca, Estevez
American oyster *Crassostrea virginica*	118, 170, 260, 285, 658, 845 Edwards, Estevez, Phillips
Common rangia *Rangia cuneata*	658
Hard clam *Mercenaria species*	297, 459, 825, 843 Edwards
Bay squid *Lolliguncula brevis*	56, 224, 510 Comp, Phillips
Brown shrimp *Peneaus aztecus*	244, 510, 692, 875 Comp, Camp
Pink shrimp *Peneaus duorarum*	658, 692 Comp, Edwards, Estevez
White shrimp *Penaeus setiferus*	658, 692
Grass shrimp *Palaemonetes pugio*	16, 225, 946 Phillips
Spiny lobster *Panulirus argus*	938 Hunt, Estevez
Blue crab *Callinectes sapidus*	392, 602, 658, 875, 938, 946 Steele
Gulf stone crab *Menippe adina*	947
Stone crab *Menippe mercenaria*	508, 511, 938, 947 Bert
Bull shark *Carcharhinus leucas*	77, 157, 829, 843 Comp, Heuter
Tarpon *Megalops atlanticus*	219, 719, 843 Edwards
Alabama shad *Alosa alabamae*	909
Gulf menhaden *Brevoortia patronus*	494, 909 Mahmoudi, Edwards, Phillips
Yellowfin menhaden *Brevoortia smithii*	152, 843, 875 Mahmoudi, Phillips
Gizzard shad *Dorosoma cepedianum*	460, 504, 839 Comp, Phillips
Bay anchovy *Anchoa mitchilli*	165, 750, 938 Comp, Edwards, Estevez
Hardhead catfish *Arius felis*	56, 508, 510, 645, 719, 733, 843 Comp, Phillips
Sheepshead minow *Cyprinodon variegatus*	165, 342, 719, 733 Comp, Phillips
Gulf killifish *Fundulus grandis*	235, 310, 469, 719, 843, 860 Comp, Phillips
Silversides *Menidia species*	165, 469, 508, 689, 710, 719, 733, 843, 875 Comp, Phillips
Snook *Centropomus undecemalis*	483, 504, 542, 588, 843, 923 Edwards
Bluefish *Pomatomus saltatrix*	342, 539, 658, 843
Blue runner *Caranx crysos*	447, 587, 776, 843, 875 Edwards
Crevalle jack *Caranx hippos*	776, 843, 875 Edwards
Florida pompano *Trachinotus carolinus*	258, 843 Phillips
Gray snapper *Lutjanus griseus*	843 Edwards
Sheepshead *Archosargus probatocephalus*	56, 219, 445, 469, 483, 508, 510, 687, 689, 733, 843, 875, 938 Comp, Phillips
Pinfish *Lagodon rhomboides*	165, 219, 643, 843 Comp, Edwards, Estevez
Silver perch *Bairdiella chysoura*	165, 219, 469, 504, 508, 510, 689, 710, 719, 733, 843 Comp, Phillips
Sand seatrout *Cynoscion arenarius*	218, 219, 843, 875 Comp, Phillips
Spotted seatrout *Cynoscion nebulosus*	219, 446, 504, 589, 658, 875, 928, 937 Comp, Phillips
Spot *Leiostomus xanthurus*	165, 219, 509, 719, 843, 875 Comp, Phillips
Atlantic croaker *Micropogonias undulatus*	495, 509, 843, 875 Phillips
Black drum *Pogonias cromis*	56, 443, 469, 483, 508, 510, 649, 689, 706, 719, 843 Comp, Phillips
Red drum *Sciaenops ocellatus*	650, 658, 705, 711, 719, 752, 875 Estevez, Phillips
Striped mullet *Mugil cephalus*	163, 165, 719, 752, 843, 875 Edwards, Estevez, Phillips
Code goby *Gobiosoma robustum*	79, 274, 840, 843
Spanish mackerel *Scomberomorus maculatus*	298, 475, 483, 694, 875 Comp
Gulf flounder *Paralichthys albigutta*	165, 219, 719, 843, 875, 904 Phillips
Southern flounder *Paralicthys lethostigma*	165, 219, 719, 732, 733, 843, 875

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Suwannee River, FL
Bay scallop *Argopecten irradians*	
American oyster *Crassostrea virginica*	360, 500, 845 Lindberg
Common rangia *Rangia cuneata*	491, 952 Gilbert, Marelli
Hard clam *Mercenaria species*	249, 459, 525, 825 Menzel, Nordlie
Bay squid *Lolliguncula brevis*	56 Clugston, Nordlie
Brown shrimp *Peneaus aztecus*	172, 331, 332, 500, 692 Sheridan
Pink shrimp *Peneaus duorarum*	64, 435, 500, 658, 692 Sheridan
White shrimp *Penaeus setiferus*	500, 644, 658, 692, 946 Sheridan
Grass shrimp *Palaemonetes pugio*	16, 361, 946 Sheridan
Spiny lobster *Panulirus argus*	658
Blue crab *Callinectes sapidus*	500, 699, 846, 910 Steele
Gulf stone crab *Menippe adina*	500, 947 Bert, Lindberg
Stone crab *Menippe mercenaria*	500, 947 Bert, Lindberg
Bull shark *Carcharhinus leucas*	77, 157, 829 Clugston, Nordlie
Tarpon *Megalops atlanticus*	219, 500, 658
Alabama shad *Alosa alabamae*	35, 265, 504, 909 Clugston, Gilbert
Gulf menhaden *Brevoortia patronus*	152, 217, 219, 493, 909, 913 Ahrenholz
Yellowfin menhaden *Brevoortia smithii*	909
Gizzard shad *Dorosoma cepedianum*	35, 188, 265, 460 Clugston, Nordlie, Gilbert
Bay anchovy *Anchoa mitchilli*	469, 733, 750
Hardhead catfish *Arius felis*	56, 645 Clugston, Nordlie
Sheepshead minow *Cyprinodon variegatus*	469, 733
Gulf killifish *Fundulus grandis*	469
Silversides *Menidia species*	Clugston, Nordlie
Snook *Centropomus undecemalis*	658, 733, 747
Bluefish *Pomatomus saltatrix*	259, 500, 658, 733
Blue runner *Caranx crysos*	59, 60, 301, 302, 349, 447, 733
Crevalle jack *Caranx hippos*	59, 174, 324, 447, 666, 733, 921
Florida pompano *Trachinotus carolinus*	
Gray snapper *Lutjanus griseus*	35, 504, 658
Sheepshead *Archosargus probatocephalus*	35, 56, 219, 265, 445, 469, 500, 733 Clugston, Nordlie
Pinfish *Lagodon rhomboides*	217, 219, 469, 642, 643, 733
Silver perch *Bairdiella chysoura*	165, 219, 469, 510, 719, 733, 843 Clugston, Nordlie
Sand seatrout *Cynoscion arenarius*	218, 219, 658, 816 Lindberg
Spotted seatrout *Cynoscion nebulosus*	219, 500, 595, 673 Lindberg
Spot *Leiostomus xanthurus*	35, 217, 219, 275, 469, 733
Atlantic croaker *Micropogonias undulatus*	217, 219, 275, 500 Nordlie, Warlen
Black drum *Pogonias cromis*	56 Clugston, Nordlie
Red drum *Sciaenops ocellatus*	420, 500, 515, 596, 597, 658, 731
Striped mullet *Mugil cephalus*	219, 500 Clugston, Nordlie
Code goby *Gobiosoma robustum*	469, 733
Spanish mackerel *Scomberomorus maculatus*	217, 219, 261, 298, 463
Gulf flounder *Paralichthys albigutta*	35, 219, 265, 311, 313, 469, 642, 733
Southern flounder *Paralicthys lethostigma*	35, 219, 504, 904 Clugston, Nordlie

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Apalachee Bay, FL
Bay scallop *Argopecten irradians*	592, 778 Menzel, Subrahmanyam
American oyster *Crassostrea virginica*	360, 594, 592, 845 Subrahmanyam
Common rangia *Rangia cuneata*	491, 592 Subrahmanyam
Hard clam *Mercenaria species*	Menzel, Subrahmanyam
Bay squid *Lolliguncula brevis*	56 Subrahmanyam
Brown shrimp *Peneaus aztecus*	1, 151, 172, 234, 308, 331, 332, 425, 426, 692 Sheridan, Subrahmanyam
Pink shrimp *Peneaus duorarum*	436, 592, 658, 692, 859, 946 Sheridan, Subrahmanyam
White shrimp *Penaeus setiferus*	512, 513, 520, 644, 658, 692, 946 Sheridan, Subrahmanyam
Grass shrimp *Palaemonetes pugio*	859, 946 Menzel, Sheridan, Subrahmanyam
Spiny lobster *Panulirus argus*	658 Subrahmanyam
Blue crab *Callinectes sapidus*	392, 658, 699, 846, 963 Steele, Subrahmanyam
Gulf stone crab *Menippe adina*	658, 947 Bert, Menzel, Lindberg, Subrahmanyam
Stone crab *Menippe mercenaria*	658, 947 Bert, Menzel, Lindberg, Subrahmanyam
Bull shark *Carcharhinus leucas*	77, 157, 463, 512, 592, 829 Subrahmanyam
Tarpon *Megalops atlanticus*	219, 462, 463, 592, 658, 685 Subrahmanyam
Alabama shad *Alosa alabamae*	504, 766, 767 Subrahmanyam
Gulf menhaden *Brevoortia patronus*	66, 463, 493, 685, 909 Subrahmanyam
Yellowfin menhaden *Brevoortia smithii*	152, 909 Subrahmanyam
Gizzard shad *Dorosoma cepedianum*	460, 592 Subrahmanyam
Bay anchovy *Anchoa mitchilli*	76, 750, 860, 859 Subrahmanyam
Hardhead catfish *Arius felis*	56, 463, 512, 592, 645, 685, 686, 963 Subrahmanyam
Sheepshead minow *Cyprinodon variegatus*	859, 963 Subrahmanyam
Gulf killifish *Fundulus grandis*	130, 859, 963 Subrahmanyam
Silversides *Menidia species*	463, 512, 592, 685, 686, 963 Subrahmanyam
Snook *Centropomus undecemalis*	173, 462, 592, 658, 747, 955 Subrahmanyam
Bluefish *Pomatomus saltatrix*	259, 462, 463, 512, 658, 733 Subrahmanyam
Blue runner *Caranx crysos*	60, 301, 302, 462, 463, 592 Subrahmanyam
Crevalle jack *Caranx hippos*	14, 174, 324, 462, 463, 512, 592, 666, 921 Subrahmanyam
Florida pompano *Trachinotus carolinus*	462, 463, 658 Subrahmanyam
Gray snapper *Lutjanus griseus*	592 Subrahmanyam
Sheepshead *Archosargus probatocephalus*	56, 219, 445, 463, 512, 592 Subrahmanyam
Pinfish *Lagodon rhomboides*	66, 76, 219, 463, 643, 685, 860 Subrahmanyam
Silver perch *Bairdiella chysoura*	219, 463, 512, 685, 686, 963 Subrahmanyam
Sand seatrout *Cynoscion arenarius*	217, 218, 219, 658, 815, 816, 860 Menzel, Subrahmanyam
Spotted seatrout *Cynoscion nebulosus*	217, 219, 463, 476, 496, 526, 592, 598, 859, 937 Menzel, Subrahmanyam
Spot *Leiostomus xanthurus*	130, 219, 463, 805, 860, 963 Menzel, Subrahmanyam
Atlantic croaker *Micropogonias undulatus*	217, 219, 275, 463, 805, 859, 963 Subrahmanyam
Black drum *Pogonias cromis*	56, 463, 592 Subrahmanyam
Red drum *Sciaenops ocellatus*	420, 515, 596, 597, 657, 658, 731 Subrahmanyam
Striped mullet *Mugil cephalus*	163, 219, 463, 685 Subrahmanyam
Code goby *Gobiosoma robustum*	76, 502, 592 Subrahmanyam
Spanish mackerel *Scomberomorus maculatus*	217, 219, 251, 261, 298 Subrahmanyam
Gulf flounder *Paralichthys albigutta*	76, 219, 291, 512, 658, 860, 859 Subrahmanyam
Southern flounder *Paralicthys lethostigma*	76, 219, 512, 859, 860 Subrahmanyam

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Apalachicola Bay, FL
Bay scallop *Argopecten irradians*	Menzel
American oyster *Crassostrea virginica*	13, 57, 58, 514, 515, 593, 845 Menzel
Common rangia *Rangia cuneata*	491, 515, 729 Menzel
Hard clam *Mercenaria species*	Menzel
Bay squid *Lolliguncula brevis*	56, 498, 513, 515, 519, 520
Brown shrimp *Peneaus aztecus*	1, 7, 172, 177, 332, 435, 437, 506, 514, 515, 517, 519, 520, 538, 592, 692, 933 Sheridan
Pink shrimp *Peneaus duorarum*	64, 514, 515, 517, 658, 692, 729, 946 Sheridan
White shrimp *Penaeus setiferus*	514, 515, 517, 519, 520, 644, 658, 692 Sheridan
Grass shrimp *Palaemonetes pugio*	16, 361, 515, 517, 518, 729 Sheridan
Spiny lobster *Panulirus argus*	658
Blue crab *Callinectes sapidus*	514, 517, 520, 661, 662, 699, 729, 846 Steele
Gulf stone crab *Menippe adina*	511, 947 Bert, Lindberg
Stone crab *Menippe mercenaria*	511, 947 Bert, Lindberg
Bull shark *Carcharhinus leucas*	77, 157, 520, 829
Tarpon *Megalops atlanticus*	7, 219, 592, 658
Alabama shad *Alosa alabamae*	47, 499, 504, 603, 956 Menzel
Gulf menhaden *Brevoortia patronus*	66, 494, 515, 517, 518, 520, 685, 729, 805, 909
Yellowfin menhaden *Brevoortia smithii*	
Gizzard shad *Dorosoma cepedianum*	47, 115, 188, 460
Bay anchovy *Anchoa mitchilli*	66, 115, 513, 514, 515, 517, 519, 802, 805
Hardhead catfish *Arius felis*	56, 115, 518, 513, 519, 520, 515, 645
Sheepshead minow *Cyprinodon variegatus*	515, 853
Gulf killifish *Fundulus grandis*	213, 235, 512, 515
Silversides *Menidia species*	115, 513, 515, 518, 520
Snook *Centropomus undecemalis*	7, 173, 592, 747, 955
Bluefish *Pomatomus saltatrix*	7, 259, 513, 515, 518, 520, 592, 599, 658
Blue runner *Caranx crysos*	7, 60, 301, 302, 348, 349, 518, 592
Crevalle jack *Caranx hippos*	7, 174, 324, 513, 515, 518, 520, 666, 921
Florida pompano *Trachinotus carolinus*	463, 518, 539
Gray snapper *Lutjanus griseus*	518, 539
Sheepshead *Archosargus probatocephalus*	56, 66, 115, 219, 445, 518, 520, 515
Pinfish *Lagodon rhomboides*	66, 115, 219, 463, 528, 529, 643
Silver perch *Bairdiella chysoura*	66, 115, 219, 513, 518, 519, 520, 805
Sand seatrout *Cynoscion arenarius*	217, 218, 219, 514, 515, 517, 519, 520, 802, 805, 815, 816
Spotted seatrout *Cynoscion nebulosus*	66, 219, 440, 446, 476, 496, 595, 609, 673
Spot *Leiostomus xanthurus*	217, 219, 479, 514, 515, 517, 519, 520, 802, 805
Atlantic croaker *Micropogonias undulatus*	479, 504, 514, 515, 517, 519, 520, 802, 803, 945 Sheridan
Black drum *Pogonias cromis*	66, 515
Red drum *Sciaenops ocellatus*	420, 515, 596, 597, 657, 658
Striped mullet *Mugil cephalus*	47, 163, 219, 463, 658 Menzel
Code goby *Gobiosoma robustum*	66, 115, 274, 512, 840
Spanish mackerel *Scomberomorus maculatus*	66, 251, 515
Gulf flounder *Paralichthys albigutta*	219, 291, 513, 658, 686
Southern flounder *Paralicthys lethostigma*	47, 219, 291, 518, 519, 686

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	St. Andrew Bay, FL
Bay scallop *Argopecten irradians*	254, 777 Fable, Fonseca, Menzel
American oyster *Crassostrea virginica*	279, 335, 360, 845, 958 Fable, Menzel, Ogren
Common rangia *Rangia cuneata*	491 Naughton
Hard clam *Mercenaria species*	249, 279, 335 Menzel, Naughton
Bay squid *Lolliguncula brevis*	56 Fable, Finucane
Brown shrimp *Peneaus aztecus*	172, 177, 332, 435, 437, 506, 515, 519, 538, 592, 692, 933, 958 Fable, Ogren, Sheridan
Pink shrimp *Peneaus duorarum*	110, 692, 777 Ogren, Sheridan
White shrimp *Penaeus setiferus*	110, 692, 958 Ogren, Sheridan, Young
Grass shrimp *Palaemonetes pugio*	777 Fable, Ogren, Sheridan, Young
Spiny lobster *Panulirus argus*	Fable
Blue crab *Callinectes sapidus*	658, 662, 699, 777, 846, 958 Naughton, Steele
Gulf stone crab *Menippe adina*	62, 320, 511, 946, 947 Bert, Lindberg, Naughton
Stone crab *Menippe mercenaria*	947
Bull shark *Carcharhinus leucas*	77, 157, 829, 921 Fable, Finucane
Tarpon *Megalops atlanticus*	219, 349, 584, 658, 862, 921 Fable
Alabama shad *Alosa alabamae*	504, 584, 720, 721 Finucane
Gulf menhaden *Brevoortia patronus*	14, 584, 665, 720, 721, 906, 921 Finucane
Yellowfin menhaden *Brevoortia smithii*	Fable
Gizzard shad *Dorosoma cepedianum*	460 Fable, Finucane
Bay anchovy *Anchoa mitchilli*	14, 191, 665, 921 Finucane
Hardhead catfish *Arius felis*	14, 56, 584, 645, 654, 665, 720, 721, 862, 921 Fable, Finucane
Sheepshead minow *Cyprinodon variegatus*	14, 654, 720, 921 Finucane
Gulf killifish *Fundulus grandis*	191, 654, 921 Finucane
Silversides *Menidia species*	348, 654, 921 Fable, Finucane
Snook *Centropomus undecemalis*	173, 349, 658, 747, 862, 921, 955 Fable
Bluefish *Pomatomus saltatrix*	111, 250, 259, 463, 584, 658, 665, 721, 862, 906, 921 Fable
Blue runner *Caranx crysos*	14, 60, 111, 250, 301, 302, 349, 584, 665, 721, 862, 906, 921 Fable
Crevalle jack *Caranx hippos*	14, 111, 191, 349, 584, 654, 665, 721, 862, 921 Fable
Florida pompano *Trachinotus carolinus*	14, 349, 584, 721, 862 Finucane
Gray snapper *Lutjanus griseus*	14, 191, 584, 654, 665, 721, 862, 921 Fable
Sheepshead *Archosargus probatocephalus*	14, 56, 219, 348, 445, 584, 665, 721, 862, 921 Fable, Finucane
Pinfish *Lagodon rhomboides*	14, 191, 219, 349, 584, 665, 720, 721, 862, 906, 921 Fable
Silver perch *Bairdiella chysoura*	14, 191, 219, 348, 654, 665, 721, 862 Fable, Finucane
Sand seatrout *Cynoscion arenarius*	14, 218, 219, 584, 654, 665, 721, 862, 906, 921 Fable
Spotted seatrout *Cynoscion nebulosus*	14, 191, 219, 584, 654, 665, 721, 862, 906, 921 Fable
Spot *Leiostomus xanthurus*	14, 219, 349, 584, 654, 665, 721, 862, 906, 921 Fable
Atlantic croaker *Micropogonias undulatus*	14, 584, 654, 665, 720, 721, 862, 906, 921 Fable
Black drum *Pogonias cromis*	191, 584, 721, 862 Fable, Finucane
Red drum *Sciaenops ocellatus*	191, 862, 921 Fable
Striped mullet *Mugil cephalus*	14, 191, 219, 349, 584, 654, 721, 921 Fable
Code goby *Gobiosoma robustum*	654 Fable
Spanish mackerel *Scomberomorus maculatus*	251, 349, 584, 653, 665, 720, 721, 862, 906, 921 Fable
Gulf flounder *Paralichthys albigutta*	14, 219, 349, 584, 654, 665, 721, 862, 906, 921 Naughton
Southern flounder *Paralicthys lethostigma*	14, 219, 721, 862, 921 Naughton

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Choctawhatchee Bay, FL
Bay scallop *Argopecten irradians*	67 Barkuloo
American oyster *Crassostrea virginica*	116, 360, 845 Menzel, Barkuloo
Common rangia *Rangia cuneata*	67 Barkuloo
Hard clam *Mercenaria species*	67, 249 Menzel, Barkuloo
Bay squid *Lolliguncula brevis*	56, 516 Moon
Brown shrimp *Peneaus aztecus*	493, 692 Barkuloo, Sheridan
Pink shrimp *Peneaus duorarum*	516, 658, 692, 946 Barkuloo, Sheridan
White shrimp *Penaeus setiferus*	516, 658, 692, 946 Barkuloo, Sheridan
Grass shrimp *Palaemonetes pugio*	516 Barkuloo, Menzel, Sheridan
Spiny lobster *Panulirus argus*	Barkuloo
Blue crab *Callinectes sapidus*	516 Barkuloo, Steele
Gulf stone crab *Menippe adina*	62, 511, 658, 947 Barkuloo, Bert
Stone crab *Menippe mercenaria*	947
Bull shark *Carcharhinus leucas*	39, 77, 157, 829 Moon
Tarpon *Megalops atlanticus*	39, 219, 349, 658 Barkuloo
Alabama shad *Alosa alabamae*	29, 39, 47, 67, 119, 439, 504, 516, 895 Barkuloo
Gulf menhaden *Brevoortia patronus*	39, 349, 516, 895, 909 Barkuloo
Yellowfin menhaden *Brevoortia smithii*	Barkuloo
Gizzard shad *Dorosoma cepedianum*	39, 47, 460 Moon
Bay anchovy *Anchoa mitchilli*	39, 67, 119, 516, 895 Barkuloo
Hardhead catfish *Arius felis*	39, 56, 119, 439, 516, 645 Moon
Sheepshead minow *Cyprinodon variegatus*	29, 349 Barkuloo
Gulf killifish *Fundulus grandis*	29 Barkuloo
Silversides *Menidia species*	39, 67, 119, 349 Moon
Snook *Centropomus undecemalis*	173, 658, 746, 747, 955 Barkuloo
Bluefish *Pomatomus saltatrix*	259, 348, 349, 439, 516, 658, 733 Barkuloo
Blue runner *Caranx crysos*	60, 301, 302, 348, 349, 439 Barkuloo
Crevalle jack *Caranx hippos*	39, 324, 348, 349, 439, 516 Barkuloo
Florida pompano *Trachinotus carolinus*	29, 349, 439, 516 Barkuloo
Gray snapper *Lutjanus griseus*	29, 39, 349, 439, 516, 895 Barkuloo
Sheepshead *Archosargus probatocephalus*	39, 56, 119, 219, 349, 439, 445, 516 Moon
Pinfish *Lagodon rhomboides*	29, 39, 119, 219, 349, 439, 516, 895 Menzel, Barkuloo
Silver perch *Bairdiella chysoura*	39, 349, 219, 516 Moon
Sand seatrout *Cynoscion arenarius*	29, 218, 219, 349, 516, 895 Barkuloo, Menzel
Spotted seatrout *Cynoscion nebulosus*	39, 119, 219, 349, 439, 516, 895 Barkuloo, Menzel
Spot *Leiostomus xanthurus*	29, 39, 119, 219, 349, 516, 895 Barkuloo
Atlantic croaker *Micropogonias undulatus*	29, 39, 119, 349, 516, 895 Barkuloo
Black drum *Pogonias cromis*	39, 56, 349, 439 Moon
Red drum *Sciaenops ocellatus*	29, 39, 349, 439, 516, 674, 697 Barkuloo
Striped mullet *Mugil cephalus*	29, 47, 102, 119, 163, 212, 219, 349, 439, 463, 516, 658 Barkuloo
Code goby *Gobiosoma robustum*	349, 516, 895 Barkuloo
Spanish mackerel *Scomberomorus maculatus*	251, 261, 298, 349, 439, 516 Barkuloo
Gulf flounder *Paralichthys albigutta*	29, 219, 349, 439, 516, 895 Barkuloo
Southern flounder *Paralicthys lethostigma*	119, 219, 349, 516, 658, 732, 895 Barkuloo

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Pensacola Bay, FL
Bay scallop *Argopecten irradians*	174 Kruczynski, Flemer, Young
American oyster *Crassostrea virginica*	36, 37, 174 Young, Flemer
Common rangia *Rangia cuneata*	174, 491 Dardeau, Flemer, Young
Hard clam *Mercenaria species*	174 Flemer, Young
Bay squid *Lolliguncula brevis*	56, 174 Bortone
Brown shrimp *Peneaus aztecus*	37, 174, 666, 692, 959 Flemer, Sheridan, Young
Pink shrimp *Peneaus duorarum*	36, 37, 666, 692 Flemer, Sheridan, Young
White shrimp *Penaeus setiferus*	36, 37, 174, 666, 692 Flemer, Sheridan, Young
Grass shrimp *Palaemonetes pugio*	666 Flemer, Sheridan, Young
Spiny lobster *Panulirus argus*	658 Flemer, Young
Blue crab *Callinectes sapidus*	36, 37, 666, 948 Flemer, Steele, Young
Gulf stone crab *Menippe adina*	658, 947 Bert, Flemer, Young
Stone crab *Menippe mercenaria*	947
Bull shark *Carcharhinus leucas*	77, 157, 829 Bortone
Tarpon *Megalops atlanticus*	219, 658, 881, 882 Bortone, Young
Alabama shad *Alosa alabamae*	24, 37, 47, 504 Bortone, Young
Gulf menhaden *Brevoortia patronus*	36, 37, 666, 882 Bortone, Young
Yellowfin menhaden *Brevoortia smithii*	Bortone, Young
Gizzard shad *Dorosoma cepedianum*	24, 36, 37, 460 Bortone
Bay anchovy *Anchoa mitchilli*	24, 36, 37, 174, 347, 666, 882 Bortone, Young
Hardhead catfish *Arius felis*	24, 36, 37, 56, 174, 347, 645, 666, 882 Bortone
Sheepshead minow *Cyprinodon variegatus*	24, 37, 174, 347, 882 Bortone, Young
Gulf killifish *Fundulus grandis*	24, 37, 174, 347, 882 Bortone, Young
Silversides *Menidia species*	24, 36, 37, 174, 347, 666, 882 Bortone
Snook *Centropomus undecemalis*	173, 658, 746, 747, 955 Bortone, Young
Bluefish *Pomatomus saltatrix*	174, 259, 348, 347, 733 Bortone, Young
Blue runner *Caranx crysos*	60, 174, 301, 302, 348, 347 Bortone, Young
Crevalle jack *Caranx hippos*	36, 37, 174, 347, 348, 666, 882 Bortone, Young
Florida pompano *Trachinotus carolinus*	174, 347 Bortone, Young
Gray snapper *Lutjanus griseus*	174, 347, 666, 882 Bortone, Young
Sheepshead *Archosargus probatocephalus*	37, 56, 174, 219, 347, 445, 666 Bortone
Pinfish *Lagodon rhomboides*	36, 37, 174, 219, 347, 643, 666, 882 Bortone, Young
Silver perch *Bairdiella chysoura*	24, 36, 37, 219, 347, 666, 882 Bortone
Sand seatrout *Cynoscion arenarius*	24, 36, 37, 174, 218, 219, 347, 666, 882 Bortone, Young
Spotted seatrout *Cynoscion nebulosus*	24, 36, 37, 174, 219, 347, 446, 496, 595, 673, 697, 813, 882 Bortone, Young
Spot *Leiostomus xanthurus*	24, 36, 37, 174, 219, 347, 666, 882 Bortone, Young
Atlantic croaker *Micropogonias undulatus*	24, 36, 37, 174, 219, 341, 347, 504, 666, 882 Bortone, Young
Black drum *Pogonias cromis*	36, 56, 174 Bortone
Red drum *Sciaenops ocellatus*	37, 174, 347, 666, 697, 882 Bortone, Young
Striped mullet *Mugil cephalus*	24, 36, 37, 47, 163, 219, 658, 666, 882 Bortone, Young
Code goby *Gobiosoma robustum*	24, 37, 174, 347 Bortone, Young
Spanish mackerel *Scomberomorus maculatus*	174, 251, 666, 882 Bortone, Young
Gulf flounder *Paralichthys albigutta*	174, 219, 291 Bortone, Young
Southern flounder *Paralicthys lethostigma*	24, 37, 38, 174, 219, 504, 882 Bortone, Young

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Perdido Bay, FL/AL
Bay scallop *Argopecten irradians*	Flemer, Kruczynski, Young, Heath
American oyster *Crassostrea virginica*	578, 579 Flemer, Heath, Menzel, Young, Van Hoose
Common rangia *Rangia cuneata*	489, 490, 491, 872, 959 Kruczynski, Heath, Flemer, Young
Hard clam *Mercenaria species*	870 Heck, Heath, Flemer, Young
Bay squid *Lolliguncula brevis*	56 Van Hoose
Brown shrimp *Peneaus aztecus*	151, 362, 363, 521, 692, 870, 873, 874 Heath, Flemer, Sheridan, Young, Van Hoose
Pink shrimp *Peneaus duorarum*	692, 870, 873 Heath, Flemer, Sheridan, Young, Van Hoose
White shrimp *Penaeus setiferus*	692, 870, 873 Heath, Flemer, Sheridan, Young, Van Hoose
Grass shrimp *Palaemonetes pugio*	870, 873 Heath, Flemer, Sheridan, Young
Spiny lobster *Panulirus argus*	658 Heath, Flemer, Young
Blue crab *Callinectes sapidus*	870, 873, 948 Heath, Flemer, Lane, Steele, Young, Van Hoose
Gulf stone crab *Menippe adina*	870, 947 Bert, Heath, Flemer, Young
Stone crab *Menippe mercenaria*	947
Bull shark *Carcharhinus leucas*	77, 157, 829 Van Hoose
Tarpon *Megalops atlanticus*	24, 658, 870 Heath, Young
Alabama shad *Alosa alabamae*	504, 870, 873 Heath, Young
Gulf menhaden *Brevoortia patronus*	870, 873 Heath, Young, Van Hoose
Yellowfin menhaden *Brevoortia smithii*	Heath, Young
Gizzard shad *Dorosoma cepedianum*	460 Van Hoose
Bay anchovy *Anchoa mitchilli*	870, 873 Heath, Young, Van Hoose
Hardhead catfish *Arius felis*	56, 645 Van Hoose
Sheepshead minow *Cyprinodon variegatus*	870, 873 Heath, Young
Gulf killifish *Fundulus grandis*	870, 873 Heath, Young
Silversides *Menidia species*	56 Van Hoose
Snook *Centropomus undecemalis*	24, 658, 746, 747, 955 Heath, Young
Bluefish *Pomatomus saltatrix*	259, 658, 733 Heath, Young
Blue runner *Caranx crysos*	60, 301, 302, 348, 347 Heath, Young
Crevalle jack *Caranx hippos*	324, 866, 873 Heath, Young
Florida pompano *Trachinotus carolinus*	870 Heath, Young
Gray snapper *Lutjanus griseus*	870 Heath, Young
Sheepshead *Archosargus probatocephalus*	56, 219, 445 Van Hoose
Pinfish *Lagodon rhomboides*	219, 866, 870, 873 Heath, Young, Van Hoose
Silver perch *Bairdiella chysoura*	56, 219 Van Hoose
Sand seatrout *Cynoscion arenarius*	218, 219, 866, 870 Heath, Young
Spotted seatrout *Cynoscion nebulosus*	219, 870 Heath, Young
Spot *Leiostomus xanthurus*	219, 866, 870, 873 Heath, Young, Van Hoose
Atlantic croaker *Micropogonias undulatus*	866, 870 Heath, Young, Van Hoose
Black drum *Pogonias cromis*	56 Van Hoose
Red drum *Sciaenops ocellatus*	870 Heath, Young, Van Hoose
Striped mullet *Mugil cephalus*	219, 870, 873 Heath, Young, Van Hoose
Code goby *Gobiosoma robustum*	811, 870, 873 Heath, Young
Spanish mackerel *Scomberomorus maculatus*	870 Heath, Young
Gulf flounder *Paralichthys albigutta*	219, 873 Heath, Young
Southern flounder *Paralicthys lethostigma*	219, 870 Heath, Young

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Mobile Bay, AL
Bay scallop *Argopecten irradians*	870, 873 Dardeau, Heath, Shipp
American oyster *Crassostrea virginica*	238, 363, 503, 578, 579, 580, 581, 582, 795 Dardeau, Heath, Shipp
Common rangia *Rangia cuneata*	464, 491, 870, 872, 922 Dardeau, Heath, Shipp
Hard clam *Mercenaria species*	249, 872 Dardeau, Heath, Shipp
Bay squid *Lolliguncula brevis*	56 Shipp, Van Hoose
Brown shrimp *Peneaus aztecus*	151, 362, 363, 521, 692, 828, 870, 874 Dardeau, Heath, Sheridan, Shipp
Pink shrimp *Peneaus duorarum*	56, 153, 692, 870, 873 Dardeau, Heath, Sheridan, Shipp
White shrimp *Penaeus setiferus*	56, 153, 522, 523, 692, 769 Dardeau, Heath, Sheridan, Shipp
Grass shrimp *Palaemonetes pugio*	71, 810, 870, 873 Dardeau, Heath, Sheridan, Shipp
Spiny lobster *Panulirus argus*	Dardeau, Heath, Shipp
Blue crab *Callinectes sapidus*	56, 363, 527, 581, 810, 846, 888, 948 Dardeau, Heath, Shipp, Steele
Gulf stone crab *Menippe adina*	870, 947 Bert, Dardeau, Heath, Shipp, VanHoose
Stone crab *Menippe mercenaria*	947
Bull shark *Carcharhinus leucas*	77, 157, 829 Shipp, Van Hoose
Tarpon *Megalops atlanticus*	243, 870, 924, 925 Heath, Shipp
Alabama shad *Alosa alabamae*	499, 504, 603, 766, 767, 870, 873, 908, 949 Heath, Shipp
Gulf menhaden *Brevoortia patronus*	56, 363, 811, 812, 814, 869, 873, 950 Heath, Shipp
Yellowfin menhaden *Brevoortia smithii*	56, 812, 814, 869, 870, 873, 950 Heath, Shipp
Gizzard shad *Dorosoma cepedianum*	460, 811, 908 Shipp, Van Hoose
Bay anchovy *Anchoa mitchilli*	814 Heath, Shipp, VanHoose
Hardhead catfish *Arius felis*	56, 645, 811 Shipp, Van Hoose
Sheepshead minow *Cyprinodon variegatus*	811, 869, 873 Heath, Shipp
Gulf killifish *Fundulus grandis*	811, 869, 873 Heath, Shipp
Silversides *Menidia species*	811, 812, 813, 814, 869, 908 Shipp, Van Hoose
Snook *Centropomus undecemalis*	Heath, Shipp
Bluefish *Pomatomus saltatrix*	56, 259, 263, 870 Heath, Shipp
Blue runner *Caranx crysos*	447, 814, 870 Heath, Shipp
Crevalle jack *Caranx hippos*	14, 72, 812, 870, 873 Heath, Shipp
Florida pompano *Trachinotus carolinus*	56, 869, 870, 924 Heath, Shipp
Gray snapper *Lutjanus griseus*	56, 869, 870 Heath, Shipp
Sheepshead *Archosargus probatocephalus*	56, 219, 445, 811, 812, 813, 814, 908 Shipp, Van Hoose
Pinfish *Lagodon rhomboides*	56, 72, 219, 811, 814, 869, 870, 873, 908 Heath, Shipp
Silver perch *Bairdiella chysoura*	219, 504, 811, 812, 813, 869, 950 Shipp, Van Hoose
Sand seatrout *Cynoscion arenarius*	56, 72, 218, 219, 363, 811, 812, 813, 814, 869, 870, 873, 908, 924, 950 Heath, Shipp
Spotted seatrout *Cynoscion nebulosus*	56, 72, 219, 363, 504, 811, 812, 813, 814, 873, 908, 911, 924, 950 Heath, Shipp
Spot *Leiostomus xanthurus*	56, 217, 219, 363, 656, 811, 812, 814, 869, 870, 873, 950 Heath, Shipp, Van Hoose
Atlantic croaker *Micropogonias undulatus*	217, 219, 363, 504, 515, 656, 812, 813, 814, 869, 870, 871, 873, 924, 945, 950 Heath, Shipp
Black drum *Pogonias cromis*	811, 812, 813, 814, 950 Shipp, Van Hoose
Red drum *Sciaenops ocellatus*	56, 72, 363, 634, 811, 812, 813, 814, 869, 870, 908, 911, 924, 950 Heath, Shipp
Striped mullet *Mugil cephalus*	56, 72, 219, 363, 811, 812, 869, 870, 873, 908, 924 Heath, Shipp
Code goby *Gobiosoma robustum*	811, 812, 813, 870, 873 Heath, Shipp
Spanish mackerel *Scomberomorus maculatus*	56, 72, 363, 812, 814, 869, 870, 924 Heath, Shipp
Gulf flounder *Paralichthys albigutta*	56, 72, 219, 870, 873, 924, 949 Heath, Shipp
Southern flounder *Paralicthys lethostigma*	56, 72, 219, 363, 504, 812, 869, 870, 873, 924 Heath, Shipp

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Mississippi Sound, MS/AL/LA
Bay scallop *Argopecten irradians*	155, 631 Demoran
American oyster *Crassostrea virginica*	73, 124, 129, 155, 231, 245, 319, 328, 536, 631, 663, 664 Demoran
Common rangia *Rangia cuneata*	155, 601, 631 Demoran
Hard clam *Mercenaria species*	155, 631 Demoran
Bay squid *Lolliguncula brevis*	32, 56, 155, 631, 700, 743, 744, 870, 932 Warren
Brown shrimp *Peneaus aztecus*	32, 56, 73, 153, 154, 155, 280, 319, 336, 696, 858, 870, 932, 941, 942 Warren
Pink shrimp *Peneaus duorarum*	56, 153, 154, 155, 696, 858, 870, 932 Warren
White shrimp *Penaeus setiferus*	32, 56, 73, 153, 154, 155, 280, 319, 696, 858, 870, 932, 942 Warren
Grass shrimp *Palaemonetes pugio*	32, 155, 336, 743, 744, 870, 932 Warren
Spiny lobster *Panulirus argus*	Waller
Blue crab *Callinectes sapidus*	32, 56, 73, 155, 601, 696, 700, 702, 870, 932 Warren
Gulf stone crab *Menippe adina*	32, 155, 856, 857, 947
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	6, 273, 441, 743, 744 Waller
Tarpon *Megalops atlanticus*	743, 744 Waller
Alabama shad *Alosa alabamae*	504 Warren
Gulf menhaden *Brevoortia patronus*	6, 32, 56, 155, 248, 319, 336, 530, 696, 701, 762, 768, 870, 932 Warren
Yellowfin menhaden *Brevoortia smithii*	155 Warren
Gizzard shad *Dorosoma cepedianum*	Warren
Bay anchovy *Anchoa mitchilli*	32, 56, 73, 155, 239, 273, 336, 530, 696, 701, 743, 744, 762, 768, 870, 932 Warren
Hardhead catfish *Arius felis*	6, 32, 56, 155, 239, 273, 336, 346, 696, 762, 870, 930 Warren
Sheepshead minow *Cyprinodon variegatus*	155, 171, 273, 336, 696, 743, 870 Warren
Gulf killifish *Fundulus grandis*	73, 155, 171, 273, 336, 696, 743, 764 Warren
Silversides *Menidia species*	32, 56, 155, 171, 273, 286, 696, 743, 762, 768, 870 Warren
Snook *Centropomus undecemalis*	Waller
Bluefish *Pomatomus saltatrix*	6, 56, 441, 743, 744, 762 Waller
Blue runner *Caranx crysos*	155, 219, 273, 743, 744, 798 Warren
Crevalle jack *Caranx hippos*	6, 32, 56, 155, 219, 273, 441, 696, 743, 744, 762, 870, 932 Warren
Florida pompano *Trachinotus carolinus*	6, 56, 155, 696, 762, 870 Warren
Gray snapper *Lutjanus griseus*	56, 762 Warren
Sheepshead *Archosargus probatocephalus*	6, 32, 56, 155, 219, 248, 273, 336, 441, 677, 696, 762, 768, 870, 932 Warren
Pinfish *Lagodon rhomboides*	6, 56, 155, 219, 273, 441, 530, 696, 762, 768, 870, 932 Warren
Silver perch *Bairdiella chysoura*	6, 32, 155, 219, 273, 441, 504, 696, 762, 768, 870, 932 Warren
Sand seatrout *Cynoscion arenarius*	6, 32, 56, 73, 155, 218, 219, 248, 273, 336, 441, 530, 677, 696, 743, 744, 768, 870, 932 Warren
Spotted seatrout *Cynoscion nebulosus*	6, 32, 56, 73, 155, 195, 219, 248, 273, 319, 336, 441, 504, 677, 696, 768, 870, 932 Warren
Spot *Leiostomus xanthurus*	6, 32, 56, 155, 219, 273, 336, 441, 504, 530, 696, 762, 768, 870, 932 Warren
Atlantic croaker *Micropogonias undulatus*	6, 32, 56, 73, 155, 219, 248, 273, 319, 441, 504, 530, 675, 696, 768, 870, 932 Warren
Black drum *Pogonias cromis*	6, 32, 56, 73, 124, 155, 248, 319, 441, 677, 768 Warren
Red drum *Sciaenops ocellatus*	6, 56, 73, 155, 248, 273, 319, 441, 504, 531, 674, 676, 696, 768, 847 Warren
Striped mullet *Mugil cephalus*	6, 56, 73, 155, 219, 248, 273, 319, 336, 696, 762, 870 Warren
Code goby *Gobiosoma robustum*	743, 744 Warren
Spanish mackerel *Scomberomorus maculatus*	6, 32, 56, 155, 219, 441, 696, 743, 744, 762, 870, 932 Warren
Gulf flounder *Paralichthys albigutta*	56, 155, 219, 273 Warren
Southern flounder *Paralicthys lethostigma*	6, 32, 56, 155, 219, 248, 273, 441, 504, 677, 696, 762, 768, 932 Warren

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Lake Borgne, LA
Bay scallop *Argopecten irradians*	 Savoie, Soniat
American oyster *Crassostrea virginica*	73, 129, 231, 288, 319 Savoie, Soniat
Common rangia *Rangia cuneata*	267 Savoie, Soniat
Hard clam *Mercenaria species*	 Savoie
Bay squid *Lolliguncula brevis*	32, 155, 267, 696 Savoie, Soniat
Brown shrimp *Peneaus aztecus*	32, 73, 155, 201, 267, 280, 319, 696, 941, 942 Savoie, Soniat
Pink shrimp *Peneaus duorarum*	155, 696 Savoie, Soniat
White shrimp *Penaeus setiferus*	32, 73, 155, 201, 280, 319, 696, 942 Savoie, Soniat
Grass shrimp *Palaemonetes pugio*	32, 155, 267 Savoie, Soniat
Spiny lobster *Panulirus argus*	 Savoie, Soniat
Blue crab *Callinectes sapidus*	32, 73, 155, 201, 267, 696, 700, 702 Savoie, Soniat
Gulf stone crab *Menippe adina*	32, 155, 201, 696, 947 Savoie, Soniat
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	6, 267 Savoie
Tarpon *Megalops atlanticus*	 Savoie
Alabama shad *Alosa alabamae*	201, 504 Savoie
Gulf menhaden *Brevoortia patronus*	6, 32, 73, 155, 201, 267, 319, 696, 763 Savoie
Yellowfin menhaden *Brevoortia smithii*	 Savoie
Gizzard shad *Dorosoma cepedianum*	171, 201, 267, 485 Savoie
Bay anchovy *Anchoa mitchilli*	32, 73, 155, 201, 267, 696, 763 Savoie
Hardhead catfish *Arius felis*	6, 32, 155, 201, 267, 696, 763 Savoie
Sheepshead minow *Cyprinodon variegatus*	155, 267, 696 Savoie
Gulf killifish *Fundulus grandis*	155, 267, 696 Savoie
Silversides *Menidia species*	32, 155, 201, 267, 696 Savoie
Snook *Centropomus undecemalis*	 Savoie
Bluefish *Pomatomus saltatrix*	6 Savoie
Blue runner *Caranx crysos*	 Savoie
Crevalle jack *Caranx hippos*	6, 32, 155, 201, 267, 696 Savoie
Florida pompano *Trachinotus carolinus*	6, 155, 267, 696 Savoie
Gray snapper *Lutjanus griseus*	155 Savoie
Sheepshead *Archosargus probatocephalus*	5, 6, 32, 46, 155, 201, 267, 696, 763 Savoie
Pinfish *Lagodon rhomboides*	6, 155, 201, 267, 696, 763 Savoie
Silver perch *Bairdiella chysoura*	6, 155, 201, 219, 267, 696, 763 Savoie
Sand seatrout *Cynoscion arenarius*	5, 6, 32, 73, 155, 201, 218, 219, 267, 696, 763 Savoie
Spotted seatrout *Cynoscion nebulosus*	5, 6, 32, 73, 155, 201, 219, 275, 696, 763, 861 Savoie
Spot *Leiostomus xanthurus*	6, 32, 155, 201, 219, 681, 696, 763 Savoie
Atlantic croaker *Micropogonias undulatus*	5, 6, 32, 73, 155, 201, 219, 275, 681, 696, 763 Savoie
Black drum *Pogonias cromis*	5, 6, 32, 73, 201, 267 Savoie, Soniat
Red drum *Sciaenops ocellatus*	6, 73, 155, 201, 267, 696, 927 Savoie
Striped mullet *Mugil cephalus*	5, 6, 73, 155, 201, 219, 266, 486, 696 Savoie
Code goby *Gobiosoma robustum*	 Savoie
Spanish mackerel *Scomberomorus maculatus*	6, 32, 155, 201, 267, 696 Savoie
Gulf flounder *Paralichthys albigutta*	 Thompson
Southern flounder *Paralicthys lethostigma*	5, 6, 32, 155, 201, 267, 696, 763 Savoie

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Lake Pontchartrain, LA
Bay scallop *Argopecten irradians*	 Savoie, Soniat
American oyster *Crassostrea virginica*	231, 233, 467, 867, 886, 887 Savoie, Soniat
Common rangia *Rangia cuneata*	73, 196, 198, 233, 252, 315, 467, 507, 867, 884, 885, 887 Savoie, Soniat
Hard clam *Mercenaria species*	 Savoie, Soniat
Bay squid *Lolliguncula brevis*	155, 696 Savoie, Soniat
Brown shrimp *Peneaus aztecus*	73, 155, 201, 280, 389, 696, 867, 887, 941, 942 Savoie, Soniat
Pink shrimp *Peneaus duorarum*	155, 696, 867 Savoie, Soniat
White shrimp *Penaeus setiferus*	73, 155, 196, 198, 201, 280, 389, 486, 696, 867, 915, 944 Savoie, Soniat
Grass shrimp *Palaemonetes pugio*	155, 389, 486, 507, 867, 887 Savoie, Soniat
Spiny lobster *Panulirus argus*	 Savoie, Soniat
Blue crab *Callinectes sapidus*	73, 155, 196, 197, 198, 201, 389, 486, 507, 696, 867, 887 Savoie, Soniat
Gulf stone crab *Menippe adina*	155, 201, 696, 947 Savoie, Soniat
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	6, 196, 198, 210, 867 Savoie
Tarpon *Megalops atlanticus*	210, 867 Savoie
Alabama shad *Alosa alabamae*	210, 350, 504, 600 Savoie
Gulf menhaden *Brevoortia patronus*	6, 155, 196, 201, 210, 315, 350, 389, 696, 864, 867, 887 Savoie
Yellowfin menhaden *Brevoortia smithii*	 Savoie
Gizzard shad *Dorosoma cepedianum*	156, 196, 198, 201, 210, 315, 350, 486, 600, 696, 826, 887 Savoie
Bay anchovy *Anchoa mitchilli*	73, 156, 196, 198, 201, 210, 315, 350, 389, 507, 600, 696, 867, 887 Savoie
Hardhead catfish *Arius felis*	6, 155, 196, 198, 201, 210, 315, 350, 389, 441, 507, 696, 867, 887 Savoie
Sheepshead minow *Cyprinodon variegatus*	155, 196, 210, 507, 696, 867, 887 Savoie
Gulf killifish *Fundulus grandis*	73, 155, 210, 350, 507, 696, 867, 887 Savoie
Silversides *Menidia species*	155, 196, 198, 201, 210, 315, 350, 507, 600, 696, 867, 887 Savoie
Snook *Centropomus undecemalis*	 Savoie
Bluefish *Pomatomus saltatrix*	6 Savoie
Blue runner *Caranx crysos*	 Savoie
Crevalle jack *Caranx hippos*	6, 155, 196, 198, 201, 210, 350, 600, 696, 867, 887 Savoie
Florida pompano *Trachinotus carolinus*	6, 210 Savoie
Gray snapper *Lutjanus griseus*	210 Savoie
Sheepshead *Archosargus probatocephalus*	5, 6, 46, 156, 196, 198, 201, 210, 315, 350, 507, 600, 696, 887 Savoie
Pinfish *Lagodon rhomboides*	6, 155, 196, 198, 201, 210, 507, 696, 867, 887 Savoie
Silver perch *Bairdiella chysoura*	6, 155, 196, 198, 201, 210, 696, 867, 887 Savoie
Sand seatrout *Cynoscion arenarius*	5, 6, 73, 155, 196, 198, 201, 210, 218, 315, 350, 389, 507, 696, 867, 887 Savoie
Spotted seatrout *Cynoscion nebulosus*	5, 6, 73, 155, 196, 198, 201, 210, 219, 315, 319, 507, 696, 867, 887 Savoie
Spot *Leiostomus xanthurus*	6, 155, 196, 198, 201, 217, 219, 315, 507, 696, 867, 887 Savoie
Atlantic croaker *Micropogonias undulatus*	5, 6, 73, 155, 196, 198, 201, 210, 219, 315, 319, 350, 389, 507, 600, 696, 867, 887 Savoie
Black drum *Pogonias cromis*	5, 6, 73, 155, 196, 198, 201, 210, 319, 350, 696, 867, 887 Savoie
Red drum *Sciaenops ocellatus*	5, 6, 73, 155, 198, 201, 210, 319, 507, 696, 867, 887 Savoie
Striped mullet *Mugil cephalus*	6, 73, 155, 196, 198, 201, 210, 219, 315, 319, 350, 486, 600, 696, 867, 887 Savoie
Code goby *Gobiosoma robustum*	202, 210 Savoie
Spanish mackerel *Scomberomorus maculatus*	6, 201, 210, 867 Savoie
Gulf flounder *Paralichthys albigutta*	887 Thompson
Southern flounder *Paralicthys lethostigma*	5, 6, 155, 196, 198, 201, 210, 315, 350, 466, 600, 696, 867, 887 Savoie

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Breton/Chandeleur Sounds, LA
Bay scallop *Argopecten irradians*	401, 682 Ancelet
American oyster *Crassostrea virginica*	129, 230, 231, 288, 319, 401, 682, 713, 880 Ancelet
Common rangia *Rangia cuneata*	682 Ancelet
Hard clam *Mercenaria species*	232, 401, 682 Ancelet
Bay squid *Lolliguncula brevis*	32, 267, 713 Ancelet
Brown shrimp *Peneaus aztecus*	30, 31, 32, 73, 267, 280, 713, 941, 942 Ancelet
Pink shrimp *Peneaus duorarum*	401 Ancelet
White shrimp *Penaeus setiferus*	30, 31, 32, 73, 267, 280, 713, 942 Ancelet
Grass shrimp *Palaemonetes pugio*	267, 401, 713 Ancelet
Spiny lobster *Panulirus argus*	Ancelet
Blue crab *Callinectes sapidus*	32, 73, 267, 401, 713 Ancelet
Gulf stone crab *Menippe adina*	267, 401, 947 Ancelet
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	267, 321, 468 Ancelet
Tarpon *Megalops atlanticus*	Ancelet
Alabama shad *Alosa alabamae*	504 Ancelet
Gulf menhaden *Brevoortia patronus*	32, 73, 267, 318, 468, 492, 713, 763 Ancelet
Yellowfin menhaden *Brevoortia smithii*	Ancelet
Gizzard shad *Dorosoma cepedianum*	32, 267, 468, 485 Ancelet
Bay anchovy *Anchoa mitchilli*	32, 73, 267, 468, 492, 713, 763 Ancelet
Hardhead catfish *Arius felis*	32, 267, 468, 492, 713, 763 Ancelet
Sheepshead minow *Cyprinodon variegatus*	267, 468, 492, 763 Ancelet
Gulf killifish *Fundulus grandis*	267, 468, 492, 763 Ancelet
Silversides *Menidia species*	267, 468, 492 Ancelet
Snook *Centropomus undecemalis*	Ancelet
Bluefish *Pomatomus saltatrix*	492 Ancelet
Blue runner *Caranx crysos*	293, 301, 302 Ancelet
Crevalle jack *Caranx hippos*	32, 267, 293, 302, 468, 492, 713 Ancelet
Florida pompano *Trachinotus carolinus*	267, 293, 492 Ancelet
Gray snapper *Lutjanus griseus*	492 Ancelet
Sheepshead *Archosargus probatocephalus*	32, 46, 267, 468, 492, 713, 763 Ancelet
Pinfish *Lagodon rhomboides*	267, 468, 492, 713, 763 Ancelet
Silver perch *Bairdiella chysoura*	32, 267, 468, 492, 713, 763 Ancelet
Sand seatrout *Cynoscion arenarius*	32, 73, 218, 267, 468, 492, 713 Ancelet
Spotted seatrout *Cynoscion nebulosus*	32, 219, 267, 468, 492, 713 Ancelet
Spot *Leiostomus xanthurus*	32, 73, 267, 468, 492, 713, 763 Ancelet
Atlantic croaker *Micropogonias undulatus*	32, 73, 267, 468, 492, 713, 763 Ancelet
Black drum *Pogonias cromis*	32, 267, 468, 492, 713 Ancelet
Red drum *Sciaenops ocellatus*	69, 267, 468, 492, 927 Ancelet
Striped mullet *Mugil cephalus*	267, 468, 485, 492, 763 Ancelet
Code goby *Gobiosoma robustum*	492 Ancelet
Spanish mackerel *Scomberomorus maculatus*	267, 468, 492, 713 Ancelet
Gulf flounder *Paralichthys albigutta*	492 Ancelet, Thompson
Southern flounder *Paralicthys lethostigma*	32, 267, 294, 468, 492, 763 Ancelet

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Mississippi River, LA
Bay scallop *Argopecten irradians*	Ancelet
American oyster *Crassostrea virginica*	682 Ancelet
Common rangia *Rangia cuneata*	Ancelet
Hard clam *Mercenaria species*	Ancelet
Bay squid *Lolliguncula brevis*	Ancelet
Brown shrimp *Peneaus aztecus*	30, 32, 34, 73, 240, 280, 826 Ancelet
Pink shrimp *Peneaus duorarum*	Ancelet
White shrimp *Penaeus setiferus*	30, 34, 240, 280, 826 Ancelet
Grass shrimp *Palaemonetes pugio*	Ancelet
Spiny lobster *Panulirus argus*	Ancelet
Blue crab *Callinectes sapidus*	Ancelet
Gulf stone crab *Menippe adina*	947 Ancelet
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	468 Ancelet
Tarpon *Megalops atlanticus*	Ancelet
Alabama shad *Alosa alabamae*	504 Ancelet
Gulf menhaden *Brevoortia patronus*	304, 305, 468, 830, 865, 931 Ancelet
Yellowfin menhaden *Brevoortia smithii*	Ancelet
Gizzard shad *Dorosoma cepedianum*	281, 468 Ancelet
Bay anchovy *Anchoa mitchilli*	468 Ancelet
Hardhead catfish *Arius felis*	468, 505 Ancelet
Sheepshead minow *Cyprinodon variegatus*	468, 583 Ancelet
Gulf killifish *Fundulus grandis*	468, 583 Ancelet
Silversides *Menidia species*	281, 468 Ancelet
Snook *Centropomus undecemalis*	Ancelet
Bluefish *Pomatomus saltatrix*	Ancelet
Blue runner *Caranx crysos*	Ancelet
Crevalle jack *Caranx hippos*	302, 468 Ancelet
Florida pompano *Trachinotus carolinus*	Ancelet
Gray snapper *Lutjanus griseus*	Ancelet
Sheepshead *Archosargus probatocephalus*	46, 468 Ancelet
Pinfish *Lagodon rhomboides*	468 Ancelet
Silver perch *Bairdiella chysoura*	468 Ancelet
Sand seatrout *Cynoscion arenarius*	218, 468 Ancelet
Spotted seatrout *Cynoscion nebulosus*	468, 830 Ancelet
Spot *Leiostomus xanthurus*	303, 304, 468 Ancelet
Atlantic croaker *Micropogonias undulatus*	304, 468, 830 Ancelet
Black drum *Pogonias cromis*	468 Ancelet
Red drum *Sciaenops ocellatus*	468 Ancelet
Striped mullet *Mugil cephalus*	468 Ancelet
Code goby *Gobiosoma robustum*	Ancelet
Spanish mackerel *Scomberomorus maculatus*	468 Ancelet
Gulf flounder *Paralichthys albigutta*	Ancelet, Thompson
Southern flounder *Paralicthys lethostigma*	468 Ancelet

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Barataria Bay, LA
Bay scallop *Argopecten irradians*	 Dameier, Schexnayder
American oyster *Crassostrea virginica*	117, 207, 266, 288, 319, 398, 912 Dameier, Schexnayder
Common rangia *Rangia cuneata*	117, 712 Dameier, Schexnayder
Hard clam *Mercenaria species*	 Dameier, Schexnayder
Bay squid *Lolliguncula brevis*	32 Dameier, Schexnayder
Brown shrimp *Peneaus aztecus*	30, 31, 32, 33, 34, 65, 73, 126, 168, 207, 280, 316, 319, 442, 826, 844, 941, 942 Dameier, Schexnayder
Pink shrimp *Peneaus duorarum*	 Dameier, Schexnayder
White shrimp *Penaeus setiferus*	30, 31, 32, 33, 34, 65, 73, 126, 168, 207, 280, 319, 826, 942 Dameier, Schexnayder
Grass shrimp *Palaemonetes pugio*	32, 126 Dameier, Schexnayder
Spiny lobster *Panulirus argus*	 Dameier, Schexnayder
Blue crab *Callinectes sapidus*	32, 73, 126, 207, 444, 961 Dameier, Schexnayder
Gulf stone crab *Menippe adina*	32, 427, 947 Dameier, Schexnayder
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	23, 210, 314 Dameier, Schexnayder
Tarpon *Megalops atlanticus*	210, 314 Dameier, Schexnayder
Alabama shad *Alosa alabamae*	210, 271, 314, 504 Dameier, Schexnayder
Gulf menhaden *Brevoortia patronus*	23, 32, 73, 126, 207, 210, 217, 219, 236, 271, 304, 305, 314, 316, 322, 765, 775, 821, 830, 926, 931, 961 Dameier, Schexnayder
Yellowfin menhaden *Brevoortia smithii*	 Dameier, Schexnayder
Gizzard shad *Dorosoma cepedianum*	23, 32, 126, 210, 236, 314, 765, 775, 926, 961 Dameier, Schexnayder
Bay anchovy *Anchoa mitchilli*	23, 32, 73, 126, 207, 210, 236, 271, 314, 322, 775, 926 Dameier, Schexnayder
Hardhead catfish *Arius felis*	23, 32, 126, 210, 236, 271, 314, 765, 775 Dameier, Schexnayder
Sheepshead minow *Cyprinodon variegatus*	23, 126, 207, 210, 236, 270, 271, 314, 765, 775 Dameier, Schexnayder
Gulf killifish *Fundulus grandis*	23, 126, 207, 210, 236, 270, 271, 310, 314, 765, 775 Dameier, Schexnayder
Silversides *Menidia species*	23, 32, 126, 207, 210, 236, 271, 314, 765, 775, 961 Dameier, Schexnayder
Snook *Centropomus undecemalis*	317 Dameier, Schexnayder
Bluefish *Pomatomus saltatrix*	126, 210, 236, 271, 314 Dameier, Schexnayder
Blue runner *Caranx crysos*	271, 293, 301, 302, 314 Dameier, Schexnayder
Crevalle jack *Caranx hippos*	23, 32, 210, 236, 271, 293, 314, 322, 775 Dameier, Schexnayder
Florida pompano *Trachinotus carolinus*	12, 23, 32, 48, 49, 210, 236, 271, 293, 314, 775 Dameier, Schexnayder
Gray snapper *Lutjanus griseus*	23, 210, 314, 775 Dameier, Schexnayder
Sheepshead *Archosargus probatocephalus*	23, 32, 126, 210, 217, 219, 236, 264, 271, 314, 765, 775 Dameier, Schexnayder
Pinfish *Lagodon rhomboides*	23, 126, 210, 217, 219, 236, 264, 271, 314, 765, 775 Dameier, Schexnayder
Silver perch *Bairdiella chysoura*	23, 32, 126, 210, 219, 236, 271, 314, 322, 775 Dameier, Schexnayder
Sand seatrout *Cynoscion arenarius*	23, 32, 73, 126, 207, 210, 217, 218, 219, 236, 271, 314, 322, 775 Dameier, Schexnayder
Spotted seatrout *Cynoscion nebulosus*	23, 32, 126, 207, 210, 219, 236, 271, 314, 322, 374, 376, 707, 765, 775, 830 Dameier, Schexnayder
Spot *Leiostomus xanthurus*	23, 32, 73, 126, 207, 210, 217, 219, 236, 271, 275, 303, 304, 305, 314, 322, 755, 765, 775, 926 Dameier, Schexnayder
Atlantic croaker *Micropogonias undulatus*	23, 32, 73, 126, 207, 210, 217, 219, 236, 271, 275, 304, 303, 305, 314, 322, 755, 758, 775, 830, 926, 961 Dameier, Schexnayder
Black drum *Pogonias cromis*	23, 126, 210, 227, 271, 314, 765, 775 Dameier, Schexnayder
Red drum *Sciaenops ocellatus*	40, 126, 210, 217, 219, 271, 314, 375, 707, 765, 775, 927 Dameier, Schexnayder
Striped mullet *Mugil cephalus*	23, 126, 207, 210, 217, 219, 271, 314, 765, 775, 961 Dameier, Schexnayder
Code goby *Gobiosoma robustum*	210, 314 Dameier, Schexnayder
Spanish mackerel *Scomberomorus maculatus*	23, 32, 126, 210, 214, 217, 219, 271, 314, 775 Dameier, Schexnayder
Gulf flounder *Paralichthys albigutta*	271, 775 Dameier, Schexnayder, Thompson
Southern flounder *Paralicthys lethostigma*	23, 32, 126, 210, 236, 271, 272, 314, 322, 775, 801 Dameier, Schexnayder

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Terrebonne/Timbalier Bays, LA
Bay scallop *Argopecten irradians*	 Adkins, Bourgeois, Guillory
American oyster *Crassostrea virginica*	288 Adkins, Bourgeois, Guillory
Common rangia *Rangia cuneata*	 Adkins, Bourgeois, Guillory
Hard clam *Mercenaria species*	253 Adkins, Bourgeois, Guillory
Bay squid *Lolliguncula brevis*	4, 32 Adkins, Bourgeois, Guillory
Brown shrimp *Peneaus aztecus*	4, 30, 31, 32, 73, 253, 280, 316, 941, 942 Adkins, Bourgeois, Guillory
Pink shrimp *Peneaus duorarum*	4, 31, 32 Adkins, Bourgeois, Guillory
White shrimp *Penaeus setiferus*	4, 30, 31, 32, 73, 280, 534, 942 Adkins, Bourgeois, Guillory
Grass shrimp *Palaemonetes pugio*	4, 32 Adkins, Bourgeois, Guillory
Spiny lobster *Panulirus argus*	 Adkins, Bourgeois, Guillory
Blue crab *Callinectes sapidus*	2, 3, 4, 32, 73, 253
Gulf stone crab *Menippe adina*	3, 4, 947 Adkins, Bourgeois, Guillory
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	3, 5 Adkins, Bourgeois, Guillory
Tarpon *Megalops atlanticus*	5 Adkins, Bourgeois, Guillory
Alabama shad *Alosa alabamae*	 Adkins, Bourgeois, Guillory
Gulf menhaden *Brevoortia patronus*	3, 4, 32, 73, 316, 698 Adkins, Bourgeois, Guillory
Yellowfin menhaden *Brevoortia smithii*	 Adkins, Bourgeois, Guillory
Gizzard shad *Dorosoma cepedianum*	3, 4, 32, 698 Adkins, Bourgeois, Guillory
Bay anchovy *Anchoa mitchilli*	4, 32, 73, 698 Adkins, Bourgeois, Guillory
Hardhead catfish *Arius felis*	3, 4, 5, 32, 698 Adkins, Bourgeois, Guillory
Sheepshead minow *Cyprinodon variegatus*	4 Adkins, Bourgeois, Guillory
Gulf killifish *Fundulus grandis*	4 Adkins, Bourgeois, Guillory
Silversides *Menidia species*	4
Snook *Centropomus undecemalis*	 Adkins, Bourgeois, Guillory
Bluefish *Pomatomus saltatrix*	3, 4, 5, 698 Adkins, Bourgeois, Guillory
Blue runner *Caranx crysos*	5, 301, 302 Adkins, Bourgeois, Guillory
Crevalle jack *Caranx hippos*	3, 4, 5, 32, 698 Adkins, Bourgeois, Guillory
Florida pompano *Trachinotus carolinus*	3, 5 Adkins, Bourgeois, Guillory
Gray snapper *Lutjanus griseus*	4, 5 Adkins, Bourgeois, Guillory
Sheepshead *Archosargus probatocephalus*	3, 4, 5 Adkins, Bourgeois, Guillory
Pinfish *Lagodon rhomboides*	3, 4, 5, 32
Silver perch *Bairdiella chysoura*	3, 4, 32, 219, 698 Adkins, Bourgeois, Guillory
Sand seatrout *Cynoscion arenarius*	3, 4, 32, 73, 218, 698
Spotted seatrout *Cynoscion nebulosus*	3, 4, 5, 32, 219, 698 Adkins, Bourgeois, Guillory
Spot *Leiostomus xanthurus*	3, 4, 5, 32, 73, 698 Adkins, Bourgeois, Guillory
Atlantic croaker *Micropogonias undulatus*	3, 4, 5, 32, 73, 698 Adkins, Bourgeois, Guillory
Black drum *Pogonias cromis*	3, 4 Adkins, Bourgeois, Guillory
Red drum *Sciaenops ocellatus*	3, 4, 5, 927 Adkins, Bourgeois, Guillory
Striped mullet *Mugil cephalus*	3, 4, 32 Adkins, Bourgeois, Guillory
Code goby *Gobiosoma robustum*	 Adkins, Bourgeois, Guillory
Spanish mackerel *Scomberomorus maculatus*	3, 4, 5, 698 Adkins, Bourgeois, Guillory
Gulf flounder *Paralichthys albigutta*	 Adkins, Bourgeois, Guillory, Thompson
Southern flounder *Paralicthys lethostigma*	3, 4, 5, 32, 698 Adkins, Bourgeois, Guillory

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Atchafalaya/Vermillion Bays, LA
Bay scallop *Argopecten irradians*	Juneau, D. Rogers
American oyster *Crassostrea virginica*	319 Juneau, D. Rogers
Common rangia *Rangia cuneata*	229, 299, 300, 397, 481 Juneau, D. Rogers
Hard clam *Mercenaria species*	Juneau, D. Rogers
Bay squid *Lolliguncula brevis*	32, 465 Juneau, D. Rogers
Brown shrimp *Peneaus aztecus*	30, 31, 32, 73, 228, 229, 280, 364, 380, 385, 465, 466, 481, 760, 934, 935 Juneau, D. Rogers
Pink shrimp *Peneaus duorarum*	Juneau, D. Rogers
White shrimp *Penaeus setiferus*	30, 31, 32, 73, 228, 229, 280, 364, 380, 465, 466, 481, 534, 760, 934, 935, 942 Juneau, D. Rogers
Grass shrimp *Palaemonetes pugio*	32, 380, 418, 465, 481, 760, 934, 935 Juneau, D. Rogers
Spiny lobster *Panulirus argus*	Juneau, D. Rogers
Blue crab *Callinectes sapidus*	32, 73, 228, 229, 380, 418, 465, 481, 693, 760, 934, 935 Juneau, D. Rogers
Gulf stone crab *Menippe adina*	32, 465, 947 Juneau, D. Rogers
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	120, 210, 659 Juneau, D. Rogers
Tarpon *Megalops atlanticus*	659 Juneau, D. Rogers
Alabama shad *Alosa alabamae*	Juneau, D. Rogers
Gulf menhaden *Brevoortia patronus*	32, 73, 208, 209, 210, 211, 228, 229, 418, 465, 481, 659, 695, 760, 883, 934, 935 Juneau, D. Rogers
Yellowfin menhaden *Brevoortia smithii*	659 Juneau, D. Rogers
Gizzard shad *Dorosoma cepedianum*	32, 210, 229, 292, 380, 418, 465, 481, 485, 659, 695, 883, 934, 935 Juneau, D. Rogers
Bay anchovy *Anchoa mitchilli*	32, 73, 210, 229, 380, 418, 465, 481, 659, 695, 760, 883, 935 Juneau, D. Rogers
Hardhead catfish *Arius felis*	32, 210, 229, 380, 465, 481, 659, 695, 883, 934, 935 Juneau, D. Rogers
Sheepshead minow *Cyprinodon variegatus*	210, 380, 418, 465, 659, 760, 883, 934, 935 Juneau, D. Rogers
Gulf killifish *Fundulus grandis*	210, 380, 418, 465, 659, 760, 883, 935 Juneau, D. Rogers
Silversides *Menidia species*	210, 380, 418, 465, 659, 695, 760, 883, 934, 935 Juneau, D. Rogers
Snook *Centropomus undecemalis*	Juneau, D. Rogers
Bluefish *Pomatomus saltatrix*	434, 883 Juneau, D. Rogers
Blue runner *Caranx crysos*	434 Juneau, D. Rogers
Crevalle jack *Caranx hippos*	210, 228, 380, 418, 465, 659, 695, 883, 935 Juneau, D. Rogers
Florida pompano *Trachinotus carolinus*	659, 883 Juneau, D. Rogers
Gray snapper *Lutjanus griseus*	883 Juneau, D. Rogers
Sheepshead *Archosargus probatocephalus*	32, 210, 228, 229, 380, 418, 465, 466, 659, 695, 883, 934, 935 Juneau, D. Rogers
Pinfish *Lagodon rhomboides*	210, 229, 380, 418, 465, 481, 659, 695, 883, 934, 935 Juneau, D. Rogers
Silver perch *Bairdiella chysoura*	32, 210, 380, 418, 465, 481, 659, 695, 883, 935 Juneau, D. Rogers
Sand seatrout *Cynoscion arenarius*	32, 73, 210, 218, 228, 229, 380, 418, 465, 466, 481, 659, 695, 760, 883, 935 Juneau, D. Rogers
Spotted seatrout *Cynoscion nebulosus*	32, 210, 219, 228, 229, 380, 383, 465, 481, 659, 695, 883 Juneau, D. Rogers
Spot *Leiostomus xanthurus*	32, 73, 210, 228, 229, 380, 418, 465, 466, 481, 659, 695, 760, 883, 934, 935 Juneau, D. Rogers
Atlantic croaker *Micropogonias undulatus*	32, 73, 210, 228, 380, 418, 465, 466, 481, 659, 695, 760, 883, 934, 935 Juneau, D. Rogers
Black drum *Pogonias cromis*	32, 210, 229, 380, 418, 465, 466, 481, 659, 695, 883, 934, 935 Juneau, D. Rogers
Red drum *Sciaenops ocellatus*	210, 465, 481, 659, 883, 927, 934, 935 Juneau, D. Rogers
Striped mullet *Mugil cephalus*	210, 228, 229, 292, 380, 418, 465, 485, 659, 695, 760, 883, 934, 935 Juneau, D. Rogers
Code goby *Gobiosoma robustum*	Juneau, D. Rogers
Spanish mackerel *Scomberomorus maculatus*	32, 228, 465, 659, 695, 883 Juneau, D. Rogers
Gulf flounder *Paralichthys albigutta*	Juneau, D. Rogers, Thompson
Southern flounder *Paralicthys lethostigma*	32, 210, 228, 229, 380, 465, 466, 481, 659, 695, 883, 934, 935 Juneau, D. Rogers

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Calcasieu Lake, LA
Bay scallop *Argopecten irradians*	Carver, Ferguson, B. Rogers
American oyster *Crassostrea virginica*	288, 319, 914, 943 Carver, Ferguson, B. Rogers
Common rangia *Rangia cuneata*	287, 397 Carver, Ferguson, B. Rogers
Hard clam *Mercenaria species*	Carver, Ferguson, B. Rogers
Bay squid *Lolliguncula brevis*	27, 32, 434, 917, 918, 919 Carver, Ferguson, B. Rogers
Brown shrimp *Peneaus aztecus*	30, 31, 32, 73, 280, 287, 316, 345, 381, 382, 384, 434, 478, 540, 703, 756, 757, 759, 941, 942 Carver, Ferguson, B. Rogers
Pink shrimp *Peneaus duorarum*	Carver, Ferguson, B. Rogers
White shrimp *Penaeus setiferus*	30, 31, 32, 73, 280, 381, 382, 384, 434, 540, 678, 703, 756, 757, 759, 942 Carver, Ferguson, B. Rogers
Grass shrimp *Palaemonetes pugio*	32, 287, 381, 384, 756, 757, 759 Carver, Ferguson, B. Rogers
Spiny lobster *Panulirus argus*	Carver, Ferguson, B. Rogers
Blue crab *Callinectes sapidus*	32, 73, 287, 345, 381, 382, 384, 434, 756, 757, 759 Carver, Ferguson, B. Rogers
Gulf stone crab *Menippe adina*	32, 757, 947 Carver, Ferguson, B. Rogers
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	21 Carver, Ferguson, B. Rogers
Tarpon *Megalops atlanticus*	Carver, Ferguson, B. Rogers
Alabama shad *Alosa alabamae*	Carver, Ferguson, B. Rogers
Gulf menhaden *Brevoortia patronus*	21, 32, 73, 255, 256, 257, 316, 345, 381, 382, 384, 434, 540, 541, 756, 757, 759, 797, 800, 799, 915, 916 Carver, Ferguson, B. Rogers
Yellowfin menhaden *Brevoortia smithii*	704 Carver, Ferguson, B. Rogers
Gizzard shad *Dorosoma cepedianum*	21, 32, 255, 256, 381, 704, 757 Carver, Ferguson, B. Rogers
Bay anchovy *Anchoa mitchilli*	21, 32, 73, 257, 345, 381, 382, 384, 434, 704, 756, 757, 759, 915, 916 Carver, Ferguson, B. Rogers
Hardhead catfish *Arius felis*	21, 32, 381, 434, 704, 756, 757 Carver, Ferguson, B. Rogers
Sheepshead minow *Cyprinodon variegatus*	21, 255, 256, 381, 384, 704, 756, 757, 759 Carver, Ferguson, B. Rogers
Gulf killifish *Fundulus grandis*	21, 256, 381, 384, 704, 756 Carver, Ferguson, B. Rogers
Silversides *Menidia species*	32, 255, 256, 381, 384, 704, 756, 757, 759 Carver, Ferguson, B. Rogers
Snook *Centropomus undecemalis*	Carver, Ferguson, B. Rogers
Bluefish *Pomatomus saltatrix*	21 Carver, Ferguson, B. Rogers
Blue runner *Caranx crysos*	Carver, Ferguson, B. Rogers
Crevalle jack *Caranx hippos*	32, 434, 704, 757 Carver, Ferguson, B. Rogers
Florida pompano *Trachinotus carolinus*	48, 49, 434, 757 Carver, Ferguson, B. Rogers
Gray snapper *Lutjanus griseus*	757 Carver, Ferguson, B. Rogers
Sheepshead *Archosargus probatocephalus*	21, 32, 381, 434, 704, 757 Carver, Ferguson, B. Rogers
Pinfish *Lagodon rhomboides*	21, 32, 384, 434, 757 Carver, Ferguson, B. Rogers
Silver perch *Bairdiella chysoura*	21, 32, 384, 434, 704, 757 Carver, Ferguson, B. Rogers
Sand seatrout *Cynoscion arenarius*	21, 32, 73, 184, 186, 187, 218, 345, 381, 382, 384, 434, 704, 756, 757, 759, 799, 934 Carver, Ferguson, B. Rogers
Spotted seatrout *Cynoscion nebulosus*	21, 32, 219, 381, 382, 383, 384, 434, 704, 756, 757 Carver, Ferguson, B. Rogers
Spot *Leiostomus xanthurus*	21, 32, 73, 184, 186, 381, 382, 384, 434, 704, 757 Carver, Ferguson, B. Rogers
Atlantic croaker *Micropogonias undulatus*	21, 22, 32, 73, 156, 184, 185, 186, 345, 381, 382, 384, 434, 477, 540, 704, 756, 757, 759, 944, 945 Carver, Ferguson, B. Rogers
Black drum *Pogonias cromis*	21, 32, 184, 186, 384, 434, 757 Carver, Ferguson, B. Rogers
Red drum *Sciaenops ocellatus*	21, 32, 381, 384, 434, 704, 756, 757, 927 Carver, Ferguson, B. Rogers
Striped mullet *Mugil cephalus*	21, 32, 345, 381, 382, 384, 434, 604, 704, 756, 757 Carver, Ferguson, B. Rogers
Code goby *Gobiosoma robustum*	757 Carver, Ferguson, B. Rogers
Spanish mackerel *Scomberomorus maculatus*	21, 32, 434, 757 Carver, Ferguson, B. Rogers
Gulf flounder *Paralichthys albigutta*	757 Carver, Ferguson, B. Rogers, Thompson
Southern flounder *Paralicthys lethostigma*	21, 32, 381, 384, 434, 704, 756, 757 Carver, Ferguson, B. Rogers

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Sabine Lake, TX/LA
Bay scallop *Argopecten irradians*	LeBlanc, Mambretti
American oyster *Crassostrea virginica*	339, 377, 480, 850 LeBlanc, Mambretti
Common rangia *Rangia cuneata*	17, 480, 850, 954 LeBlanc, Mambretti
Hard clam *Mercenaria species*	LeBlanc, Mambretti
Bay squid *Lolliguncula brevis*	850 LeBlanc, Mambretti
Brown shrimp *Peneaus aztecus*	339, 377, 501, 591, 611, 612, 850, 954 LeBlanc, Mambretti
Pink shrimp *Peneaus duorarum*	339, 377, 591, 611, 612 LeBlanc, Mambretti
White shrimp *Penaeus setiferus*	337, 339, 377, 501, 591, 611, 612, 850, 852, 954 LeBlanc, Mambretti
Grass shrimp *Palaemonetes pugio*	954 LeBlanc, Mambretti
Spiny lobster *Panulirus argus*	Pattillo
Blue crab *Callinectes sapidus*	337, 339, 591, 639, 850, 954 LeBlanc, Mambretti
Gulf stone crab *Menippe adina*	947 LeBlanc, Mambretti
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	Green, LeBlanc, Mambretti
Tarpon *Megalops atlanticus*	LeBlanc, Mambretti
Alabama shad *Alosa alabamae*	LeBlanc, Mambretti
Gulf menhaden *Brevoortia patronus*	591, 742, 797, 800, 849 LeBlanc, Mambretti
Yellowfin menhaden *Brevoortia smithii*	Pattillo
Gizzard shad *Dorosoma cepedianum*	849 LeBlanc, Mambretti
Bay anchovy *Anchoa mitchilli*	591, 849 LeBlanc, Mambretti
Hardhead catfish *Arius felis*	742, 849 LeBlanc, Mambretti
Sheepshead minow *Cyprinodon variegatus*	849 LeBlanc, Mambretti
Gulf killifish *Fundulus grandis*	849 LeBlanc, Mambretti
Silversides *Menidia species*	LeBlanc, Mambretti
Snook *Centropomus undecemalis*	LeBlanc, Mambretti
Bluefish *Pomatomus saltatrix*	849 LeBlanc, Mambretti
Blue runner *Caranx crysos*	Pattillo
Crevalle jack *Caranx hippos*	849 LeBlanc, Mambretti
Florida pompano *Trachinotus carolinus*	LeBlanc, Mambretti
Gray snapper *Lutjanus griseus*	LeBlanc, Mambretti
Sheepshead *Archosargus probatocephalus*	337, 742, 849 LeBlanc, Mambretti
Pinfish *Lagodon rhomboides*	591, 849 LeBlanc, Mambretti
Silver perch *Bairdiella chysoura*	LeBlanc, Mambretti
Sand seatrout *Cynoscion arenarius*	218, 337, 591, 742, 849 LeBlanc, Mambretti
Spotted seatrout *Cynoscion nebulosus*	219, 337, 591, 742, 849 LeBlanc, Mambretti
Spot *Leiostomus xanthurus*	591, 742, 849 LeBlanc, Mambretti
Atlantic croaker *Micropogonias undulatus*	337, 591, 742, 849 LeBlanc, Mambretti
Black drum *Pogonias cromis*	337, 591, 742, 849 LeBlanc, Mambretti
Red drum *Sciaenops ocellatus*	193, 337, 591, 742, 849 LeBlanc, Mambretti
Striped mullet *Mugil cephalus*	337, 591, 742, 849 LeBlanc, Mambretti
Code goby *Gobiosoma robustum*	LeBlanc, Mambretti
Spanish mackerel *Scomberomorus maculatus*	591, 849 LeBlanc, Mambretti
Gulf flounder *Paralichthys albigutta*	LeBlanc, Mambretti
Southern flounder *Paralicthys lethostigma*	569, 591, 742, 849 LeBlanc, Mambretti

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Galveston Bay, TX
Bay scallop *Argopecten irradians*	623, 809 Benefield, Trimm
American oyster *Crassostrea virginica*	52, 215, 337, 339, 340, 367, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 537, 586, 684, 723, 735, 809, 834, 835, 967. Benefield, Trimm
Common rangia *Rangia cuneata*	17, 26, 454, 537, 623, 723, 809, 967 Benefield, Trimm
Hard clam *Mercenaria species*	189, 190, 215, 415, 453, 586, 623, 809 Benefield, Trimm
Bay squid *Lolliguncula brevis*	20, 113, 142, 390, 391, 537, 586, 623, 723, 735, 809 Benefield, Forsythe, Trimm
Brown shrimp *Peneaus aztecus*	8, 17, 43, 44, 53-55, 122, 125, 127, 150, 169, 178, 289, 337, 339, 340, 454-457, 484, 501, 566, 575, 576, 586, 591, 605, 607, 608, 611-625, 680, 691, 723, 725, 727, 735, 739, 809, 889, 905, 907, 960, 965, 967, 968, 970. Baxter, Benefield, Trimm
Pink shrimp *Peneaus duorarum*	53, 54, 55, 150, 339, 340, 484, 575, 586, 591, 611-625, 809, 889, 907, 967, 968 Baxter, Benefield, Trimm
White shrimp *Penaeus setiferus*	8, 17, 20, 26, 44, 53, 54, 55, 125, 127, 150, 159, 169, 178, 237, 337, 339, 340, 421, 454-457, 484, 501, 537, 575, 586, 591, 605, 608, 611-625, 691, 723, 725, 727, 728, 735, 739, 806, 809, 889, 907, 960, 966, 967, 968. Baxter, Benefield, Trimm
Grass shrimp *Palaemonetes pugio*	17, 127, 169, 178, 421, 454, 455, 537, 586, 623, 691, 723, 809, 907, 929, 953, 968 Benefield, Trimm
Spiny lobster *Panulirus argus*	Pattillo
Blue crab *Callinectes sapidus*	10, 17, 20, 26, 50, 54, 55, 127, 135, 142, 147, 169, 178, 282, 337, 338, 339, 340, 454, 455, 456, 537, 586, 591, 627, 637, 638, 639, 640, 667, 691, 723, 726, 735, 809, 893, 894, 907, 967, 968. Benefield, Trimm
Gulf stone crab *Menippe adina*	178, 402, 405, 454, 623, 723, 809, 947, 968 Benefield, Trimm
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	42, 77, 307, 623, 679, 722, 724, 739 Benefield, Green, Trimm
Tarpon *Megalops atlanticus*	247, 679, 968 Benefield, Trimm
Alabama shad *Alosa alabamae*	Benefield, Trimm
Gulf menhaden *Brevoortia patronus*	17, 20, 26, 45, 127, 169, 178, 192, 268, 283, 284, 393, 416, 421, 454, 455, 456, 487, 488, 537, 573, 585, 586, 591, 623, 679, 722, 724, 734, 735, 737, 739, 742, 804, 967, 968. Benefield, Trimm
Yellowfin menhaden *Brevoortia smithii*	Pattillo
Gizzard shad *Dorosoma cepedianum*	17, 20, 127, 169, 178, 284, 487, 537, 586, 623, 679, 722, 724, 734, 735, 737, 739, 804 Benefield, Trimm
Bay anchovy *Anchoa mitchilli*	17, 20, 45, 127, 169, 178, 216, 283, 284, 393, 421, 454, 455, 487, 537, 573, 586, 623, 679, 722, 724, 734, 735, 737, 739, 804, 967, 968. Benefield, Trimm
Hardhead catfish *Arius felis*	17, 20, 45, 127, 178, 192, 216, 283, 284, 487, 488, 537, 585, 586, 591, 623, 679, 722, 724, 734, 735, 737, 537, 742, 804, 807, 808, 968. Benefield, Trimm
Sheepshead minow *Cyprinodon variegatus*	9, 20, 127, 169, 178, 284, 453, 455, 487, 543, 544, 586, 623, 679, 722, 724, 735, 737, 739, 804, 824, 968 Benefield, Trimm
Gulf killifish *Fundulus grandis*	9, 20, 127, 169, 216, 453, 455, 487, 586, 623, 679, 722, 724, 735, 737, 739, 804, 824, 967, 968 Benefield, Trimm
Silversides *Menidia species*	9, 17, 20, 127, 169, 216, 283, 421, 455, 586, 623, 734, 737, 739, 804, 967, 968 Benefield, Trimm
Snook *Centropomus undecemalis*	574, 586 Benefield, Trimm
Bluefish *Pomatomus saltatrix*	20, 487, 623, 679, 724, 739, 967 Benefield, Trimm
Blue runner *Caranx crysos*	679 Pattillo
Crevalle jack *Caranx hippos*	20, 45, 178, 284, 393, 487, 488, 586, 623, 679, 722, 724, 734, 737, 804 Benefield, Trimm
Florida pompano *Trachinotus carolinus*	20, 284, 337, 623, 679, 734, 737, 739 Benefield, Trimm
Gray snapper *Lutjanus griseus*	623, 679 Benefield, Trimm
Sheepshead *Archosargus probatocephalus*	17, 20, 45, 85, 88-91, 192, 284, 337, 393, 488, 537, 546, 570, 585, 586, 591, 623, 635, 636, 670, 672, 722, 724, 734, 735, 737, 739, 742, 804, 851, 852, 967, 968. Benefield, Trimm
Pinfish *Lagodon rhomboides*	9, 17, 20, 127, 169, 192, 216, 284, 393, 421, 487, 488, 585, 586, 591, 623, 679, 724, 734, 735, 737, 739, 742, 804, 967, 968 Benefield, Trimm
Silver perch *Bairdiella chysoura*	20, 178, 216, 219, 284, 393, 487, 488, 586, 623, 679, 722, 724, 734-737, 739, 804, 967 Benefield, Trimm
Sand seatrout *Cynoscion arenarius*	17, 20, 45, 51, 127, 169, 178, 192, 216, 218, 283, 284, 337, 393, 421, 455, 487, 488, 537, 585, 586, 591, 623, 626, 670, 679, 722, 724, 734-737, 742, 804, 807, 808. Benefield, Trimm
Spotted seatrout *Cynoscion nebulosus*	17, 20, 25, 85, 88-91, 127, 192, 193, 216, 219, 284, 337, 393, 453, 454, 488, 537, 546, 547, 570, 585, 586, 591, 623, 635, 636, 670, 672, 679, 722, 724, 734, 735, 737, 739, 742, 804, 851, 852, 967, 968. Benefield, Trimm
Spot *Leiostomus xanthurus*	9, 17, 20, 45, 127, 169, 178, 192, 216, 283, 284, 393, 421, 453, 454, 487, 488, 537, 585, 586, 591, 623, 679, 724, 735, 737, 738, 739, 742, 804, 807, 808, 967, 968. Benefield, Trimm
Atlantic croaker *Micropogonias undulatus*	17, 20, 45, 85, 127, 169, 178, 192, 216, 220, 283, 284, 337, 393, 453, 454, 455, 487, 488, 537, 573, 585, 586, 591, 623, 670, 672, 679, 722, 724, 734-739, 742, 804, 807, 808, 851, 852, 945, 968. Benefield, Trimm
Black drum *Pogonias cromis*	17, 20, 85, 88-91, 127, 178, 192, 216, 221, 284, 337, 393, 453, 454, 487, 488, 537, 546, 547, 568, 570, 585, 586, 591, 623, 635, 636, 670, 672, 679, 722, 724, 734, 735, 737, 739, 742, 804, 851, 852. Benefield, Trimm
Red drum *Sciaenops ocellatus*	17, 20, 85, 88-91, 127, 192, 193, 216, 221, 284, 337, 373, 393, 453, 454, 487, 488, 546, 547, 563-567, 570, 585, 586, 591, 623, 635, 636, 670-672, 679, 722, 734-737, 739, 742, 804, 851, 852, 939, 968. Benefield, Trimm
Striped mullet *Mugil cephalus*	9, 17, 20, 127, 169, 178, 192, 283, 284, 337, 393, 421, 453, 454, 487, 488, 537, 586, 591, 623, 679, 722, 724, 735, 737, 739, 742, 804, 967, 968. Benefield, Trimm
Code goby *Gobiosoma robustum*	284, 487, 586, 623, 679, 968 Benefield, Trimm
Spanish mackerel *Scomberomorus maculatus*	41, 487, 591, 623, 679, 734, 739 Benefield, Trimm
Gulf flounder *Paralichthys albigutta*	178, 284, 421, 562, 586, 679 Benefield, Trimm
Southern flounder *Paralicthys lethostigma*	17, 20, 85, 88-91, 169, 178, 192, 216, 284, 393, 453, 454, 455, 537, 546, 547, 562, 569, 570, 585, 586, 591, 623, 628, 635, 636, 670, 672, 679, 722, 724, 734-737, 739, 742, 804, 838, 851, 852, 967, 968. Benefield, Trimm

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Brazos River, TX
Bay scallop *Argopecten irradians*	
American oyster *Crassostrea virginica*	457
Common rangia *Rangia cuneata*	
Hard clam *Mercenaria species*	
Bay squid *Lolliguncula brevis*	113, 457
Brown shrimp *Peneaus aztecus*	125, 457
Pink shrimp *Peneaus duorarum*	457
White shrimp *Penaeus setiferus*	18, 125, 457
Grass shrimp *Palaemonetes pugio*	457
Spiny lobster *Panulirus argus*	Pattillo
Blue crab *Callinectes sapidus*	457
Gulf stone crab *Menippe adina*	457, 947
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	77
Tarpon *Megalops atlanticus*	18, 457
Alabama shad *Alosa alabamae*	
Gulf menhaden *Brevoortia patronus*	18, 457
Yellowfin menhaden *Brevoortia smithii*	Pattillo
Gizzard shad *Dorosoma cepedianum*	18, 457
Bay anchovy *Anchoa mitchilli*	18, 457
Hardhead catfish *Arius felis*	18, 457
Sheepshead minow *Cyprinodon variegatus*	18, 457
Gulf killifish *Fundulus grandis*	18, 457
Silversides *Menidia species*	457
Snook *Centropomus undecemalis*	
Bluefish *Pomatomus saltatrix*	457
Blue runner *Caranx crysos*	Pattillo
Crevalle jack *Caranx hippos*	457
Florida pompano *Trachinotus carolinus*	457
Gray snapper *Lutjanus griseus*	
Sheepshead *Archosargus probatocephalus*	457
Pinfish *Lagodon rhomboides*	18, 457
Silver perch *Bairdiella chysoura*	219, 457
Sand seatrout *Cynoscion arenarius*	218, 457, 816
Spotted seatrout *Cynoscion nebulosus*	18, 219, 457
Spot *Leiostomus xanthurus*	18, 457
Atlantic croaker *Micropogonias undulatus*	18, 457
Black drum *Pogonias cromis*	457, 761
Red drum *Sciaenops ocellatus*	457, 761
Striped mullet *Mugil cephalus*	18, 457
Code goby *Gobiosoma robustum*	
Spanish mackerel *Scomberomorus maculatus*	457
Gulf flounder *Paralichthys albigutta*	
Southern flounder *Paralicthys lethostigma*	457, 569

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Matagorda Bay, TX
Bay scallop *Argopecten irradians*	Dailey, Weixelman
American oyster *Crassostrea virginica*	204, 206, 337, 339, 367, 404, 403, 406, 407, 409, 410, 470, 472, 533, 629, 929 Dailey, Weixelman
Common rangia *Rangia cuneata*	204 Dailey, Weixelman
Hard clam *Mercenaria species*	Dailey, Weixelman
Bay squid *Lolliguncula brevis*	17, 113, 142, 204, 205, 390, 641 Dailey, Weixelman
Brown shrimp *Peneaus aztecus*	17, 53, 54, 55, 125, 204, 205, 206, 339, 340, 456, 471, 501, 575, 591, 611, 613, 614, 616-622, 624, 625, 641, 647, 651, 652, 725, 929, 969. Dailey, Weixelman
Pink shrimp *Peneaus duorarum*	54, 55, 204, 339, 575, 591, 611, 613, 614, 616-622, 624, 625, 641, 647, 651, 652, 969 Dailey, Weixelman
White shrimp *Penaeus setiferus*	17, 53, 54, 55, 125, 204, 206, 337, 339, 340, 456, 471, 501, 575, 591, 611, 613, 614, 616-622, 624, 625, 641, 647, 651, 652, 725, 929, 969. Dailey, Weixelman
Grass shrimp *Palaemonetes pugio*	205, 641, 969 Dailey, Weixelman
Spiny lobster *Panulirus argus*	Pattillo
Blue crab *Callinectes sapidus*	17, 54, 55, 135, 169, 147, 205, 206, 337, 338, 339, 340, 473, 591, 610, 638, 639, 641, 929, 969 Dailey, Weixelman
Gulf stone crab *Menippe adina*	641, 947 Dailey, Weixelman
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	307 Dailey, Green, Weixelman
Tarpon *Megalops atlanticus*	559, 969 Dailey, Weixelman
Alabama shad *Alosa alabamae*	Dailey, Weixelman
Gulf menhaden *Brevoortia patronus*	17, 192, 203, 205, 532, 585, 591, 606, 641, 742, 929, 940, 969 Dailey, Weixelman
Yellowfin menhaden *Brevoortia smithii*	Pattillo
Gizzard shad *Dorosoma cepedianum*	203, 205, 532, 641 Dailey, Weixelman
Bay anchovy *Anchoa mitchilli*	17, 203, 471, 532, 606, 641, 929, 969 Dailey, Weixelman
Hardhead catfish *Arius felis*	17, 192, 203, 532, 585, 591, 641, 939, 969 Dailey, Weixelman
Sheepshead minow *Cyprinodon variegatus*	203, 205, 532, 824, 929, 940, 969 Dailey, Weixelman
Gulf killifish *Fundulus grandis*	203, 606, 824, 969 Dailey, Weixelman
Silversides *Menidia species*	203, 205, 532, 606, 641, 969 Dailey, Weixelman
Snook *Centropomus undecemalis*	574 Dailey, Weixelman
Bluefish *Pomatomus saltatrix*	641 Dailey, Weixelman
Blue runner *Caranx crysos*	Pattillo
Crevalle jack *Caranx hippos*	203, 532, 641 Dailey, Weixelman
Florida pompano *Trachinotus carolinus*	Dailey, Weixelman
Gray snapper *Lutjanus griseus*	Dailey, Weixelman
Sheepshead *Archosargus probatocephalus*	85, 88-91, 192, 203, 337, 471, 532, 546, 585, 591, 628, 641, 646, 670, 672, 742, 851, 969 Dailey, Weixelman
Pinfish *Lagodon rhomboides*	192, 203, 205, 532, 585, 591, 606, 641, 742, 969 Dailey, Weixelman
Silver perch *Bairdiella chysoura*	203, 219, 532, 606, 641, 969 Dailey, Weixelman
Sand seatrout *Cynoscion arenarius*	17, 192, 203, 205, 218, 337, 471, 532, 585, 591, 606, 641, 670, 672, 742 Dailey, Weixelman
Spotted seatrout *Cynoscion nebulosus*	17, 85, 88-91, 164, 192, 193, 203, 205, 219, 337, 471, 497, 532, 546, 547, 585, 591, 606, 628, 641, 646, 670, 672, 742, 851, 929, 940, 969. Dailey, Weixelman
Spot *Leiostomus xanthurus*	17, 192, 203, 471, 532, 585, 591, 606, 641, 742, 929, 940, 969 Dailey, Weixelman
Atlantic croaker *Micropogonias undulatus*	17, 85, 192, 203, 205, 337, 471, 532, 585, 591, 606, 641, 670, 672, 742, 851, 929, 940, 969 Dailey, Weixelman
Black drum *Pogonias cromis*	85, 88-91, 160, 192, 193, 203, 221, 337, 471, 546, 547, 585, 591, 628, 641, 646, 670, 672, 742, 819, 851, 929, 940 Dailey, Weixelman
Red drum *Sciaenops ocellatus*	17, 85, 88-91, 192, 193, 203, 205, 221, 337, 373, 471, 497, 546, 547, 563, 564, 571, 585, 591, 628, 641, 646, 670-672, 742, 819, 851, 929, 940, 969. Dailey, Weixelman
Striped mullet *Mugil cephalus*	17, 192, 203, 205, 219, 262, 337, 532, 591, 606, 641, 742, 929, 940, 969 Dailey, Weixelman
Code goby *Gobiosoma robustum*	203, 532, 641 Dailey, Weixelman
Spanish mackerel *Scomberomorus maculatus*	203, 532, 591, 641 Dailey, Weixelman
Gulf flounder *Paralichthys albigutta*	562 Dailey, Weixelman
Southern flounder *Paralicthys lethostigma*	17, 85, 88-91, 192, 203, 205, 378, 471, 497, 532, 546, 547, 562, 569, 585, 591, 606, 628, 641, 646, 670, 672, 742, 851, 929, 940, 969. Dailey, Weixelman

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	San Antonio Bay, TX
Bay scallop *Argopecten irradians*	683 Marwitz, Wagner
American oyster *Crassostrea virginica*	52, 132, 134, 139, 140, 145, 337, 340, 367, 394, 404, 403, 406, 408, 409, 410, 537, 577, 683, 684 Marwitz, Wagner
Common rangia *Rangia cuneata*	17, 365, 537, 577, 683 Marwitz, Wagner
Hard clam *Mercenaria species*	394, 683 Marwitz, Wagner
Bay squid *Lolliguncula brevis*	17, 132, 390, 537 Marwitz, Wagner
Brown shrimp *Peneaus aztecus*	17, 53, 54, 55, 132, 138, 144, 149, 339, 340, 394, 474, 501, 537, 575, 577, 591, 611, 613, 614, 616-622, 624, 625, 725 Marwitz, Wagner
Pink shrimp *Peneaus duorarum*	53, 54, 55, 132, 340, 394, 474, 575, 591, 611, 613, 614, 616-622, 624, 625, 725 Marwitz, Wagner
White shrimp *Penaeus setiferus*	17, 53, 54, 55, 113, 132, 138, 144, 149, 337, 339, 340, 365, 394, 474, 501, 537, 575, 577, 591, 611, 613, 614, 616-622, 624, 625, 725. Marwitz, Wagner
Grass shrimp *Palaemonetes pugio*	17, 132, 175, 537, 577 Marwitz, Wagner
Spiny lobster *Panulirus argus*	Pattillo
Blue crab *Callinectes sapidus*	17, 54, 55, 132, 134, 137, 142, 143, 147, 148, 338, 339, 340, 365, 394, 474, 537, 577, 638, 639, 820 Marwitz, Wagner
Gulf stone crab *Menippe adina*	132, 134, 537, 577, 947 Marwitz, Wagner
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	307, 394 Green, Marwitz, Wagner
Tarpon *Megalops atlanticus*	133, 823 Marwitz, Wagner
Alabama shad *Alosa alabamae*	Marwitz, Wagner
Gulf menhaden *Brevoortia patronus*	17, 132, 192, 537, 585, 591, 742 Marwitz, Wagner
Yellowfin menhaden *Brevoortia smithii*	Pattillo
Gizzard shad *Dorosoma cepedianum*	132, 133, 537 Marwitz, Wagner
Bay anchovy *Anchoa mitchilli*	17, 132, 133, 136, 141, 327, 537 Marwitz, Wagner
Hardhead catfish *Arius felis*	17, 132, 133, 192, 394, 537, 585, 591, 742, 820 Marwitz, Wagner
Sheepshead minow *Cyprinodon variegatus*	132, 327, 394, 537, 824 Marwitz, Wagner
Gulf killifish *Fundulus grandis*	327, 394, 537, 824 Marwitz, Wagner
Silversides *Menidia species*	17, 132, 133, 327, 537 Marwitz, Wagner
Snook *Centropomus undecemalis*	133, 574 Marwitz, Wagner
Bluefish *Pomatomus saltatrix*	Marwitz, Wagner
Blue runner *Caranx crysos*	Pattillo
Crevalle jack *Caranx hippos*	132, 327 Marwitz, Wagner
Florida pompano *Trachinotus carolinus*	133 Marwitz, Wagner
Gray snapper *Lutjanus griseus*	132 Marwitz, Wagner
Sheepshead *Archosargus probatocephalus*	17, 85, 91, 132, 133, 192, 337, 394, 474, 537, 546, 570, 585, 591, 670, 672, 742, 820, 851 Marwitz, Wagner
Pinfish *Lagodon rhomboides*	17, 132, 133, 136, 141, 192, 327, 585, 591, 742, 820 Marwitz, Wagner
Silver perch *Bairdiella chysoura*	132, 219, 327, 394, 820 Marwitz, Wagner
Sand seatrout *Cynoscion arenarius*	17, 132, 133, 192, 218, 394, 537, 585, 591, 670, 672, 742, 820 Marwitz, Wagner
Spotted seatrout *Cynoscion nebulosus*	17, 85, 88, 89, 91, 133, 136, 141, 146, 192, 219, 327, 337, 394, 474, 537, 546, 547, 570, 585, 591, 670, 672, 742, 820, 851. Marwitz, Wagner
Spot *Leiostomus xanthurus*	17, 132, 133, 136, 141, 192, 327, 394, 537, 585, 591, 742, 820 Marwitz, Wagner
Atlantic croaker *Micropogonias undulatus*	17, 85, 132, 133, 136, 141, 192, 327, 394, 537, 585, 591, 670, 672, 742, 820, 851 Marwitz, Wagner
Black drum *Pogonias cromis*	17, 85, 89, 91, 132, 133, 136, 141, 146, 160, 192, 221, 327, 337, 474, 537, 546, 547, 570, 585, 591, 670, 672, 742, 819, 820, 851. Marwitz, Wagner
Red drum *Sciaenops ocellatus*	17, 85, 88-91, 133, 136, 141, 146, 192, 193, 194, 221, 327, 337, 373, 474, 546, 547, 564, 570, 585, 591, 670-672, 742, 819, 820, 836, 902. Marwitz, Wagner
Striped mullet *Mugil cephalus*	17, 132, 133, 192, 262, 327, 337, 394, 537, 591, 742 Marwitz, Wagner
Code goby *Gobiosoma robustum*	537 Marwitz, Wagner
Spanish mackerel *Scomberomorus maculatus*	133, 591 Marwitz, Wagner
Gulf flounder *Paralichthys albigutta*	474, 562 Marwitz, Wagner
Southern flounder *Paralicthys lethostigma*	17, 85, 90, 91, 132, 133, 136, 141, 145, 192, 327, 394, 474, 537, 546, 547, 562, 569, 570, 585, 591, 670, 672, 742, 820, 851. Marwitz, Wagner

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Aransas Bay, TX
Bay scallop *Argopecten irradians*	400, 683, 965 Campbell, Meador
American oyster *Crassostrea virginica*	179, 337, 340, 366, 367, 368, 369, 370, 717 Campbell, Meador
Common rangia *Rangia cuneata*	365, 683 Campbell, Meador
Hard clam *Mercenaria species*	190, 683, 745 Campbell, Meador
Bay squid *Lolliguncula brevis*	17, 176, 326, 372, 390, 399, 745 Campbell, Meador
Brown shrimp *Peneaus aztecus*	17, 53, 54, 55, 166, 167, 176, 181, 277, 323, 326, 334, 339, 340, 371, 372, 399, 456, 501, 575, 591, 611, 613, 614, 616-622, 624, 625, 691, 725, 785, 788, 791. Campbell, Meador
Pink shrimp *Peneaus duorarum*	53, 54, 55, 176, 181, 277, 326, 339, 340, 372, 399, 400, 456, 575, 591, 611, 613, 614, 616-622, 624, 672, 785, 788, 791, 964. Campbell, Meador
White shrimp *Penaeus setiferus*	17, 53, 54, 55, 113, 277, 323, 326, 337, 339, 340, 365, 371, 372, 399, 456, 501, 575, 591, 611, 613, 614, 616-622, 624, 625, 691, 725, 785, 788, 791, 964. Campbell, Meador
Grass shrimp *Palaemonetes pugio*	17, 371, 372, 400, 691, 964 Campbell, Meador
Spiny lobster *Panulirus argus*	Pattillo
Blue crab *Callinectes sapidus*	17, 54, 55, 135, 142, 147, 176, 323, 326, 334, 338, 339, 340, 365, 371, 372, 400, 591, 638, 639, 691, 783, 787, 790, 964. Campbell, Meador
Gulf stone crab *Menippe adina*	326, 334, 372, 394, 716, 745, 947, 964 Campbell, Meador
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	42, 307, 395, 792, 964 Campbell, Green, Meador
Tarpon *Megalops atlanticus*	324, 842 Campbell, Meador
Alabama shad *Alosa alabamae*	Campbell, Meador
Gulf menhaden *Brevoortia patronus*	15, 17, 75, 176, 339, 323, 324, 371, 395, 399, 585, 591, 740, 742, 745 Campbell, Meador
Yellowfin menhaden *Brevoortia smithii*	Pattillo
Gizzard shad *Dorosoma cepedianum*	324, 334, 371, 372, 740, 745 Campbell, Meador
Bay anchovy *Anchoa mitchilli*	15, 17, 68, 324, 327, 329, 371, 372, 395, 399, 430, 591, 633, 740, 964 Campbell, Meador
Hardhead catfish *Arius felis*	17, 176, 192, 323, 324, 325, 334, 371, 372, 399, 585, 591, 633, 742, 745, 792, 964 Campbell, Meador
Sheepshead minow *Cyprinodon variegatus*	68, 176, 324, 327, 329, 371, 372, 543, 544, 740, 745, 824 Campbell, Meador
Gulf killifish *Fundulus grandis*	68, 310, 324, 329, 371, 372, 740, 745, 824 Campbell, Meador
Silversides *Menidia species*	15, 17, 68, 323, 324, 327, 329, 334, 371, 372, 395, 400, 430, 740, 745, 964 Campbell, Meador
Snook *Centropomus undecemalis*	574, 842 Campbell, Meador
Bluefish *Pomatomus saltatrix*	176, 324, 395, 745, 842 Campbell, Meador
Blue runner *Caranx crysos*	Campbell, Pattillo
Crevalle jack *Caranx hippos*	176, 324, 327, 371, 395, 842, 964 Campbell, Meador
Florida pompano *Trachinotus carolinus*	324, 329, 337, 395, 842 Campbell, Meador
Gray snapper *Lutjanus griseus*	334, 842 Campbell, Meador
Sheepshead *Archosargus probatocephalus*	15, 17, 68, 85, 88-91, 176, 192, 323, 324, 334, 337, 400, 546, 570, 585, 591, 670, 672, 742, 745, 784, 786, 792, 851, 964. Campbell, Meador
Pinfish *Lagodon rhomboides*	15, 17, 68, 75, 121, 176, 192, 323, 324, 327, 334, 371, 372, 395, 400, 430, 431, 432, 585, 591, 633, 742, 745, 792, 964. Campbell, Meador
Silver perch *Bairdiella chysoura*	15, 68, 75, 176, 219, 323, 324, 327, 334, 371, 372, 395, 400, 419, 422, 430, 633, 745, 792, 964 Campbell, Meador
Sand seatrout *Cynoscion arenarius*	15, 17, 176, 192, 218, 323, 324, 337, 395, 422, 585, 591, 633, 670, 672, 742, 745, 792, 920, 964 Campbell, Meador
Spotted seatrout *Cynoscion nebulosus*	15, 17, 68, 85, 88-91, 109, 176, 192, 219, 323, 324, 327, 334, 371, 372, 419, 422, 430, 546, 547, 570, 585, 591, 633, 670, 672, 688, 708, 742, 745, 784, 786, 789, 793, 842, 851, 920, 964. Campbell, Meador
Spot *Leiostomus xanthurus*	15, 17, 68, 192, 323, 324, 327, 334, 371, 372, 395, 399, 400, 422, 430, 585, 591, 633, 742, 745, 964 Campbell, Meador
Atlantic croaker *Micropogonias undulatus*	15, 17, 68, 75, 85, 176, 192, 219, 324, 329, 334, 337, 371, 372, 395, 399, 422, 430, 585, 591, 633, 670, 672, 688, 742, 745, 792, 851, 964. Campbell, Meador
Black drum *Pogonias cromis*	15, 17, 75, 85, 88-91, 160, 192, 221, 323, 324, 327, 337, 371, 372, 395, 422, 546, 547, 568, 570, 585, 591, 670, 672, 742, 786, 789, 792, 819, 851, 964. Campbell, Meador
Red drum *Sciaenops ocellatus*	15, 17, 68, 75, 85, 88-91, 192, 193, 221, 323, 324, 327, 329, 337, 371-373, 395, 400, 422, 423, 430, 546, 547, 563-565, 570, 572, 585, 591, 670-672, 688, 742, 745, 784, 786, 789, 792, 819, 836, 842, 851, 964. Campbell, Meador
Striped mullet *Mugil cephalus*	15, 17, 68, 176, 192, 262, 323, 324, 327, 334, 337, 371, 395, 400, 591, 632, 633, 740, 742, 745, 964 Campbell, Meador
Code goby *Gobiosoma robustum*	15, 68, 395, 400, 430, 431, 432, 745, 964 Campbell, Meador
Spanish mackerel *Scomberomorus maculatus*	41, 176, 324, 395, 591, 633, 741, 792, 842, 964 Campbell, Meador
Gulf flounder *Paralichthys albigutta*	15, 68, 324, 395, 430, 562, 633, 855 Campbell, Meador
Southern flounder *Paralicthys lethostigma*	15, 17, 68, 75, 85, 88, 89, 90, 176, 192, 324, 327, 372, 400, 430, 546, 547, 562, 569, 570, 585, 591, 633, 670, 672, 742, 745, 784, 786, 789, 792, 822, 851, 855, 964. Campbell, Meador

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Corpus Christi Bay, TX
Bay scallop *Argopecten irradians*	400, 417, 965 Fuls
American oyster *Crassostrea virginica*	179, 340, 379, 400, 417, 550, 553, 745 Fuls
Common rangia *Rangia cuneata*	417 Fuls
Hard clam *Mercenaria species*	190, 417, 745 Fuls
Bay squid *Lolliguncula brevis*	17, 74, 176, 343, 390, 399, 745 Fuls
Brown shrimp *Peneaus aztecus*	17, 54, 55, 74, 166, 167, 176, 181, 277, 339, 340, 343, 379, 399, 417, 501, 551, 552, 556, 575, 591, 611, 613, 614, 616-622, 624, 625, 725, 848. Fuls
Pink shrimp *Peneaus duorarum*	54, 55, 74, 176, 181, 277, 339, 340, 343, 399, 400, 575, 591, 611, 613, 614, 616-622, 624, 625, 725, 367, 848 Fuls
White shrimp *Penaeus setiferus*	17, 54, 55, 74, 113, 277, 337, 339, 340, 343, 379, 399, 501, 551, 552, 556, 575, 591, 611, 613, 614, 616-622, 624, 625, 725, 848, 964. Fuls
Grass shrimp *Palaemonetes pugio*	837, 848, 964 Fuls
Spiny lobster *Panulirus argus*	Pattillo
Blue crab *Callinectes sapidus*	17, 54, 55, 74, 135, 142, 147, 176, 338, 339, 340, 343, 379, 400, 417, 548, 555, 558, 591, 638, 639, 964 Fuls
Gulf stone crab *Menippe adina*	417, 745, 947, 964 Fuls
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	42, 307, 395, 792 Fuls, Green
Tarpon *Megalops atlanticus*	964 Fuls
Alabama shad *Alosa alabamae*	Fuls
Gulf menhaden *Brevoortia patronus*	15, 17, 75, 176, 192, 379, 395, 399, 461, 585, 591, 742, 745, 848 Fuls
Yellowfin menhaden *Brevoortia smithii*	848 Pattillo
Gizzard shad *Dorosoma cepedianum*	745 Fuls
Bay anchovy *Anchoa mitchilli*	15, 17, 68, 74, 329, 343, 395, 399, 430, 848, 964 Fuls
Hardhead catfish *Arius felis*	17, 74, 176, 192, 334, 399, 461, 585, 591, 742, 745, 792, 848, 964 Fuls
Sheepshead minow *Cyprinodon variegatus*	68, 176, 213, 329, 745, 824 Fuls
Gulf killifish *Fundulus grandis*	68, 213, 745, 824 Fuls
Silversides *Menidia species*	15, 68, 329, 334, 343, 395, 400, 430, 461, 745, 964 Fuls
Snook *Centropomus undecemalis*	504, 574, 842 Fuls
Bluefish *Pomatomus saltatrix*	176, 343, 395, 745, 842 Fuls
Blue runner *Caranx crysos*	848 Pattillo
Crevalle jack *Caranx hippos*	74, 176, 395, 842, 848, 964 Fuls
Florida pompano *Trachinotus carolinus*	329, 337, 395, 842, 848 Fuls
Gray snapper *Lutjanus griseus*	334, 842, 848 Fuls
Sheepshead *Archosargus probatocephalus*	15, 17, 68, 74, 85, 88, 89, 91, 176, 192, 334, 337, 343, 372, 400, 461, 546, 549, 554, 557, 570, 585, 591, 670, 672, 742, 745, 792, 848, 851, 964. Fuls
Pinfish *Lagodon rhomboides*	15, 17, 68, 74, 75, 121, 176, 192, 334, 343, 395, 400, 430, 431, 432, 461, 585, 591, 742, 745, 792, 848, 964 Fuls
Silver perch *Bairdiella chysoura*	15, 68, 74, 75, 176, 219, 334, 395, 419, 430, 461, 745, 792, 848, 964 Fuls
Sand seatrout *Cynoscion arenarius*	15, 17, 81, 176, 192, 218, 337, 343, 395, 400, 461, 585, 591, 670, 672, 742, 745, 792, 848, 964 Fuls
Spotted seatrout *Cynoscion nebulosus*	15, 17, 68, 85, 88-91, 109, 176, 192, 219, 334, 337, 343, 379, 419, 430, 497, 546, 547, 549, 554, 557, 570, 585, 591, 688, 708, 742, 745, 793, 842, 848, 851, 964. Fuls
Spot *Leiostomus xanthurus*	15, 17, 68, 74, 192, 334, 343, 379, 395, 399, 400, 430, 461, 585, 591, 670, 672, 848, 964 Fuls
Atlantic croaker *Micropogonias undulatus*	15, 17, 68, 74, 75, 85, 176, 192, 219, 329, 334, 337, 343, 379, 395, 399, 430, 461, 585, 591, 670, 672, 688, 742, 745, 792, 848, 851, 964. Fuls
Black drum *Pogonias cromis*	15, 17, 75, 85, 88, 89, 91, 160, 192, 221, 337, 343, 395, 546, 547, 549, 554, 557, 568, 570, 585, 591, 670, 672, 742, 792, 819, 848, 851, 964. Fuls
Red drum *Sciaenops ocellatus*	15, 17, 19, 68, 75, 85, 88-91, 192, 193, 194, 221, 329, 334, 343, 373, 395, 400, 423, 430, 497, 546, 547, 548, 554, 557, 564, 565, 570, 585, 611, 670-672, 688, 742, 745, 792, 819, 836, 842, 848, 851, 964. Fuls
Striped mullet *Mugil cephalus*	15, 17, 68, 74, 176, 192, 262, 334, 337, 343, 379, 395, 400, 461, 591, 632, 742, 745, 848, 964 Fuls
Code goby *Gobiosoma robustum*	15, 68, 396, 395, 400, 430, 431, 432, 745, 964 Fuls
Spanish mackerel *Scomberomorus maculatus*	176, 343, 395, 591, 741, 792, 842, 848, 964 Fuls
Gulf flounder *Paralichthys albigutta*	15, 68, 395, 430, 562, 848, 855 Fuls
Southern flounder *Paralicthys lethostigma*	15, 17, 19, 68, 74, 75, 85, 89, 90, 91, 176, 192, 343, 371, 400, 430, 461, 497, 546, 547, 549, 554, 557, 562, 569, 570, 585, 591, 670, 672, 742, 745, 792, 822, 848, 851, 855, 964. Fuls

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Laguna Madre, TX
Bay scallop *Argopecten irradians*	82, 128, 951 Dansby, Rice, Tunnell
American oyster *Crassostrea virginica*	81, 82, 92, 98, 112, 337, 339, 367, 403, 409, 449, 667, 684, 818 Dansby, Rice, Tunnell
Common rangia *Rangia cuneata*	Dansby, Rice, Tunnell
Hard clam *Mercenaria species*	81, 82, 415 Dansby, Rice, Tunnell
Bay squid *Lolliguncula brevis*	17, 81, 82, 92, 128, 387, 390, 796, 818 Dansby, Rice, Tunnell
Brown shrimp *Peneaus aztecus*	17, 53, 54, 55, 81, 82, 92, 96, 98, 112, 128, 277, 339, 373, 352, 355, 357, 387, 448, 451, 456, 501, 575, 591, 611, 613, 614, 616-622, 624, 625, 667, 669, 691, 725, 817, 854. Dansby, Rice, Tunnell
Pink shrimp *Peneaus duorarum*	53, 54, 55, 82, 96, 98, 277, 339, 340, 352, 355, 357, 448, 451, 456, 575, 591, 611, 613, 614, 616-622, 624, 625, 667, 669, 725, 817, 854. Dansby, Rice, Tunnell
White shrimp *Penaeus setiferus*	17, 53, 54, 55, 81, 82, 92, 96, 98, 112, 277, 339, 340, 352, 355, 357, 387, 448, 451, 456, 501, 575, 591, 611, 613, 614, 616-622, 624, 625, 667, 669, 725, 796, 817, 854. Dansby, Rice, Tunnell
Grass shrimp *Palaemonetes pugio*	17, 82, 96, 387, 691, 817, 837 Dansby, Rice, Tunnell
Spiny lobster *Panulirus argus*	Pattillo, Tunnell, Hockeday
Blue crab *Callinectes sapidus*	17, 54, 55, 81, 82, 92, 96, 98, 112, 135, 142, 147, 338, 339, 340, 344, 351, 356, 359, 387, 450, 452, 591, 638, 639, 667, 668, 691, 796, 817, 818. Dansby, Rice, Tunnell
Gulf stone crab *Menippe adina*	817, 818, 947 Dansby, Rice, Tunnell
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	42, 307 Dansby, Edwards, Green, Rice
Tarpon *Megalops atlanticus*	82, 112, 817 Dansby, Edwards, Rice
Alabama shad *Alosa alabamae*	Dansby, Edwards, Rice
Gulf menhaden *Brevoortia patronus*	17, 82, 92, 96, 98, 112, 128, 192, 387, 424, 585, 591, 742, 796, 817 Dansby, Edwards, Rice
Yellowfin menhaden *Brevoortia smithii*	Pattillo
Gizzard shad *Dorosoma cepedianum*	82, 98, 112, 344, 387, 751, 817 Dansby, Edwards, Rice
Bay anchovy *Anchoa mitchilli*	17, 83, 92, 98, 112, 128, 377, 387, 424, 751, 796, 817, 818 Dansby, Edwards, Rice
Hardhead catfish *Arius felis*	17, 81, 82, 92, 96, 98, 112, 192, 344, 377, 387, 424, 585, 591, 742, 751, 796, 817, 818 Dansby, Edwards, Rice
Sheepshead minow *Cyprinodon variegatus*	82, 96, 112, 128, 330, 354, 377, 387, 424, 751, 796, 817, 824 Dansby, Edwards, Rice
Gulf killifish *Fundulus grandis*	82, 96, 112, 128, 330, 424, 817, 824 Dansby, Edwards, Rice
Silversides *Menidia species*	330, 377, 387, 424, 742, 796, 817 Dansby, Edwards, Rice
Snook *Centropomus undecemalis*	428, 504, 574, 818 Dansby, Edwards, Rice
Bluefish *Pomatomus saltatrix*	796, 817 Dansby, Edwards, Rice
Blue runner *Caranx crysos*	Harrington, Rice, Pattillo
Crevalle jack *Caranx hippos*	82, 92, 112, 424, 796, 817 Dansby, Edwards, Rice
Florida pompano *Trachinotus carolinus*	337, 424, 796, 817 Dansby, Edwards, Rice
Gray snapper *Lutjanus griseus*	82, 424, 796 Dansby, Edwards, Rice
Sheepshead *Archosargus probatocephalus*	17, 81, 82, 85-91, 95-101, 112, 192, 337, 344, 353, 358, 354, 424, 546, 570, 585, 591, 628, 670, 672, 742, 796, 817, 851. Dansby, Edwards, Rice
Pinfish *Lagodon rhomboides*	17, 82, 83, 92, 98, 112, 128, 192, 354, 377, 424, 585, 591, 742, 796, 817, 818 Dansby, Edwards, Rice
Silver perch *Bairdiella chysoura*	82, 83, 92, 112, 128, 219, 377, 387, 424, 796, 817 Dansby, Edwards, Rice
Sand seatrout *Cynoscion arenarius*	17, 83, 98, 112, 192, 218, 337, 344, 387, 424, 585, 591, 670, 672, 742, 817 Dansby, Edwards, Rice
Spotted seatrout *Cynoscion nebulosus*	17, 81, 82, 83, 85-101, 112, 128, 192, 219, 337, 344, 353, 358, 354, 377, 387, 424, 546, 547, 570, 585, 591, 670, 672, 742, 796, 817, 818, 851. Dansby, Edwards, Rice
Spot *Leiostomus xanthurus*	192, 344, 354, 377, 387, 424, 585, 591, 742, 796, 817 Dansby, Edwards, Rice
Atlantic croaker *Micropogonias undulatus*	17, 83, 92, 96, 98, 112, 128, 192, 219, 337, 344, 377, 387, 424, 585, 591, 670, 672, 742, 751, 796, 817, 851 Dansby, Edwards, Rice
Black drum *Pogonias cromis*	17, 81-92, 94-101, 112, 192, 221, 337, 344, 353, 358, 354, 377, 387, 424, 546, 547, 568, 570, 585, 591, 670, 672, 742, 796, 817, 818, 819, 851. Dansby, Edwards, Rice
Red drum *Sciaenops ocellatus*	17, 81, 82, 83, 85-92, 94-101, 112, 128, 192, 193, 221, 337, 344, 353, 354, 358, 373, 377, 387, 424, 546, 547, 563, 564, 566, 570, 614, 741, 670, 672, 742, 751, 796, 817, 818, 819, 851. Dansby, Edwards, Rice
Striped mullet *Mugil cephalus*	17, 81, 82, 92, 96, 98, 112, 128, 192, 219, 262, 337, 344, 354, 377, 387, 424, 591, 632, 742, 751, 796, 817 Dansby, Edwards, Rice
Code goby *Gobiosoma robustum*	128, 424 Dansby, Edwards, Rice
Spanish mackerel *Scomberomorus maculatus*	82, 83, 112, 330, 591, 796 Dansby, Edwards, Rice
Gulf flounder *Paralichthys albigutta*	82, 377, 562, 817 Dansby, Edwards, Rice
Southern flounder *Paralicthys lethostigma*	17, 81, 82, 83, 85-92, 94-101, 112, 192, 330, 344, 353, 358, 377, 387, 424, 546, 547, 569, 570, 585, 591, 670, 672, 742, 817, 851. Dansby, Edwards, Rice

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Species	Baffin Bay, TX
Bay scallop *Argopecten irradians*	Martin
American oyster *Crassostrea virginica*	655 Martin
Common rangia *Rangia cuneata*	Martin
Hard clam *Mercenaria species*	Martin
Bay squid *Lolliguncula brevis*	182, 537 Martin
Brown shrimp *Peneaus aztecus*	80, 180, 537, 822 Martin
Pink shrimp *Peneaus duorarum*	822 Martin
White shrimp *Penaeus setiferus*	80, 182, 537, 822 Martin
Grass shrimp *Palaemonetes pugio*	537, 837 Martin
Spiny lobster *Panulirus argus*	Pattillo
Blue crab *Callinectes sapidus*	80, 180, 182, 537, 822 Martin
Gulf stone crab *Menippe adina*	182, 822, 947 Martin
Stone crab *Menippe mercenaria*	947 Czapla
Bull shark *Carcharhinus leucas*	Green, Martin
Tarpon *Megalops atlanticus*	80, 182 Martin
Alabama shad *Alosa alabamae*	Martin
Gulf menhaden *Brevoortia patronus*	182, 276, 482, 537, 822, 902 Martin
Yellowfin menhaden *Brevoortia smithii*	Pattillo
Gizzard shad *Dorosoma cepedianum*	80, 182, 276, 482, 822, 902 Martin
Bay anchovy *Anchoa mitchilli*	182, 222, 223, 482, 537, 822 Martin
Hardhead catfish *Arius felis*	80, 180, 182, 276, 482, 822, 902 Martin
Sheepshead minow *Cyprinodon variegatus*	80, 180, 182, 222, 223, 482, 537, 822, 824 Martin
Gulf killifish *Fundulus grandis*	80, 182, 482, 822, 824 Martin
Silversides *Menidia species*	80, 180, 182, 222, 223, 482, 537, 822 Martin
Snook *Centropomus undecemalis*	80 Martin
Bluefish *Pomatomus saltatrix*	Martin
Blue runner *Caranx crysos*	Pattillo
Crevalle jack *Caranx hippos*	822, 902 Martin
Florida pompano *Trachinotus carolinus*	Martin
Gray snapper *Lutjanus griseus*	Martin
Sheepshead *Archosargus probatocephalus*	182, 822 Martin
Pinfish *Lagodon rhomboides*	80, 180, 182, 276, 482, 537, 822, 902 Martin
Silver perch *Bairdiella chysoura*	80, 182, 219, 276, 482, 822, 902 Martin
Sand seatrout *Cynoscion arenarius*	80, 182, 218, 276, 822, 902 Martin
Spotted seatrout *Cynoscion nebulosus*	80, 180, 182, 219, 222, 223, 276, 482, 537, 822, 902 Martin
Spot *Leiostomus xanthurus*	80, 182, 222, 223, 276, 482, 537, 822, 902 Martin
Atlantic croaker *Micropogonias undulatus*	80, 180, 182, 222, 223, 276, 482, 537, 822, 902 Martin
Black drum *Pogonias cromis*	80, 180, 182, 183, 221, 222, 223, 276, 482, 537, 545, 568, 819, 822, 902 Martin
Red drum *Sciaenops ocellatus*	80, 180, 182, 221, 276, 482, 537, 819, 822, 836, 902 Martin
Striped mullet *Mugil cephalus*	80, 180, 182, 276, 482, 537, 822, 902 Martin
Code goby *Gobiosoma robustum*	182 Martin
Spanish mackerel *Scomberomorus maculatus*	Martin
Gulf flounder *Paralichthys albigutta*	822 Martin
Southern flounder *Paralicthys lethostigma*	80, 180, 182, 276, 482, 537, 569, 822, 902 Martin

Numbers correspond to references in Appendix 4, p. 230-273.
Names correspond to individuals in Appendix 3, p. 226-229.

Appendix 3. Reviewers and personal communications

Name	Affiliation
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Meeting the Gulf of Mexico Shellfish Challenge

Using Strategic Assessment to Define Strategies and Target Watersheds for Shellfish Restoration

February 1996 Update

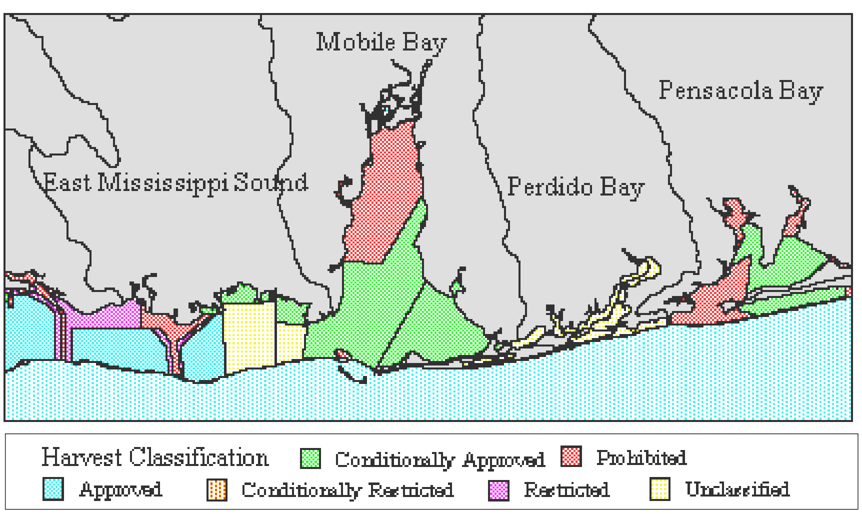
The Gulf of Mexico is the top shellfish-producing region in the nation, with over 27 million pounds of oysters landed in 1994 at a value of $96 million. However, the 1995 *National Shellfish Register* indicates over half of the nine million acres of shellfish growing waters in the region have regulatory limitations on harvest due to a variety of reasons ranging from administrative rules to degraded water quality.

The Shellfish Challenge Plan summarizes the consensus of over 50 regional specialists regarding shellfish restoration efforts. It will be released in March.

The Gulf of Mexico Program, recognizing the importance of shellfish bed closures as an indicator of the potential decline in coastal water quality, has identified the restoration of shellfish acreage as one of its top environmental objectives. This update presents the status of the first phase of this project — developing and targeting strategies for achieving the Shellfish Challenge.

A Need for Assessment

The Shellfish Challenge seeks to “increase Gulf shellfish beds available for safe harvesting by 10 percent.” To achieve this ambitious goal, the Gulf of Mexico Program needed a way to determine where and how to most effectively direct its efforts to have the greatest impact on the shellfish closure problem. In February 1994, members of the Program formed a team with the Strategic Environmental Assessments (SEA) Division of NOAA’s Office of Ocean Resources Conservation and Assessment (ORCA) to undertake a "strategic assessment" of the issues impacting shellfish bed closures in the Gulf region. The assessment set out to identify, on a Gulfwide basis, the highest-priority strategies for addressing the problem, the watersheds where these strategies could be applied, the actions needed to implement them, and the information required for them to be effective.



Harvest classification information from the 1995 Shellfish Register was used extensively by regional specialists to develop and target restoration strategies.

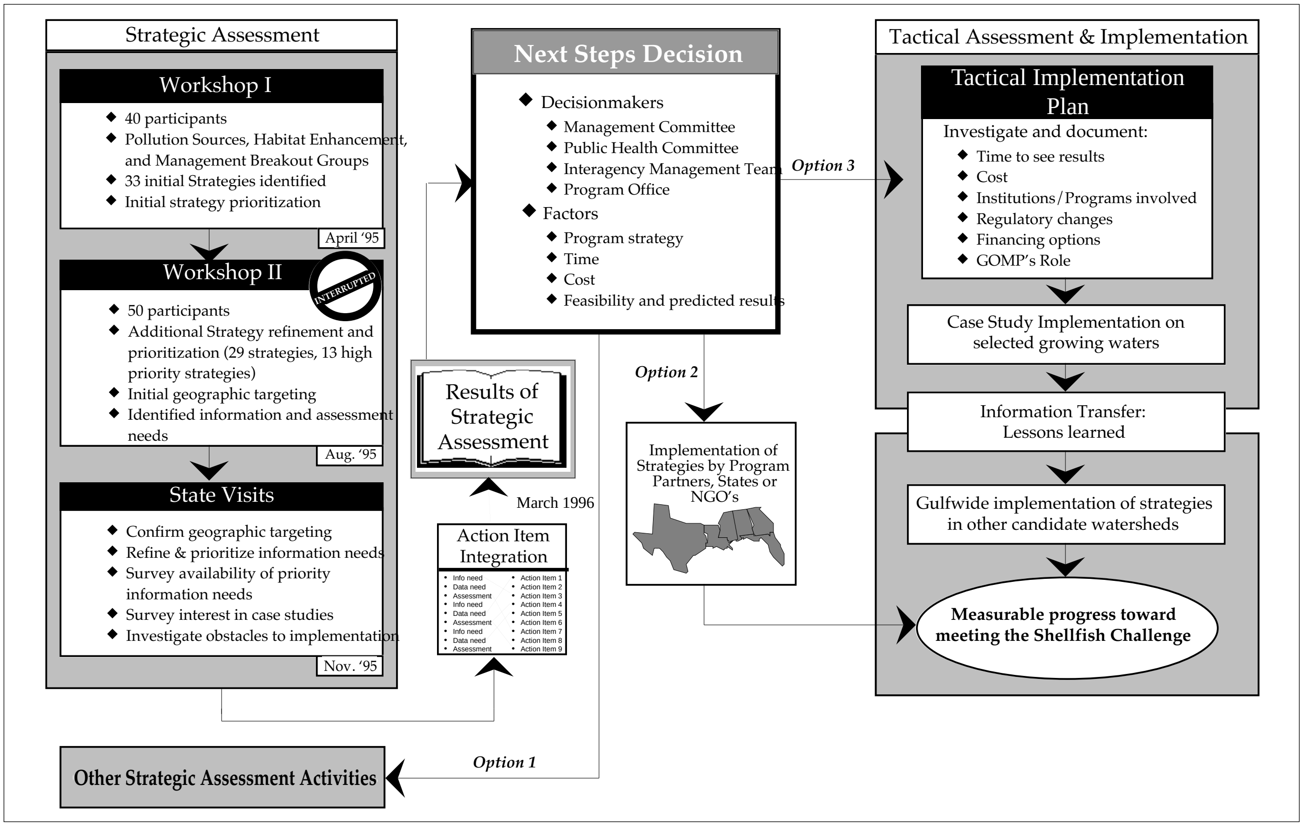
Top Shellfish Strategies

ID	Strategy Title
PS-1	Connect poorly operating septics to WWTPs
PS-5	Reduce inputs of FCBs in runoff from densely populated areas
HE-1	Use existing reservoirs and/or diversions to impact salinities > 25 ppt
HE-2	Enhance cultch/ substrate in areas with 10-25 ppt salinity
M-4	Develop improved risk assessment system for shellfish

The assessment was considered "strategic" because it sought to define the scale and scope of problems across the watersheds of the Gulf. It brought together stakeholders (including local and regional experts) with relevant data in a structured process designed to identify the most feasible strategies to meet the Challenge, while taking into account time and resource constraints and competing priorities.

Building Consensus

Two regional workshops were organized to bring together a variety of regional "experts" to



The next step in meeting the Shellfish Challenge is to develop a tactical implementation plan in selected watersheds.

develop viable environmental strategies directed at the goal. The first, held in New Orleans in April 1995, was used to identify the major issues affecting shellfish harvest restrictions. Strategies were developed by three breakout groups covering issues related to: 1) pollution sources; 2) habitat enhancement; and 3) public health and resource management. Together, these groups identified and ranked 33 strategies that could be implemented to address the shellfish issues identified.

A second workshop was held in Pensacola Beach, FL in August 1995 to modify and improve the strategies, target the watersheds in the region where specific strategies would have the best chance of being successfully implemented, and identify additional information and assessment needs critical to implementation. A series of state visits was conducted in November 1995 to complete the data collection and review process needed to draft the Shellfish Challenge Plan.

Top Strategies & Watersheds

The strategy ranking process identified five top strategies among the 13 highly ranked ones (see front sidebar). The criteria for selection varied by group, but included an assessment of the severity of the problem that the strategy addressed, the regional importance of the strategy, the likelihood that successful implementation would lead to upgrades in growing water classification or increase in shellfish habitat, and the feasibility of successfully implementing the strategy. In addition, the groups targeted and rated watersheds for their potential as candidates for strategy implementation, based on the available background data and their expert knowledge. Watersheds with the most promise for implementation of a range of strategies include Barataria and Terrebonne bays (Louisiana), Suwannee River to Apalachee Bay (Florida), Matagorda Bay (Texas), Mobile Bay (Alabama), and Mississippi Sound (Mississippi).

Next Steps

The next step in the process (see above) is to develop detailed tactical implementation plans for selected watersheds to determine exactly what costs, regulations, and timing would have to be considered for the strategies to be successfully implemented.

For More Information

For more information on meeting the Shellfish Challenge, contact either the Gulf of Mexico Program's Chief of science and technology Fred Kopfler (EPA) at (601) 688-2712 or Daniel Farrow of NOAA's SEA Division at (301) 713-3000, x156.